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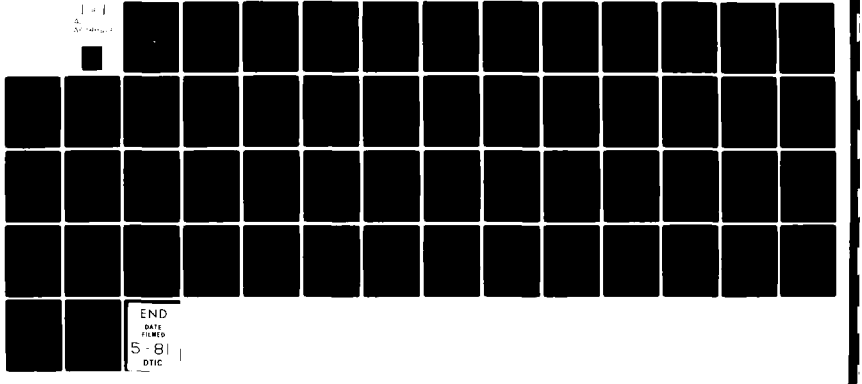

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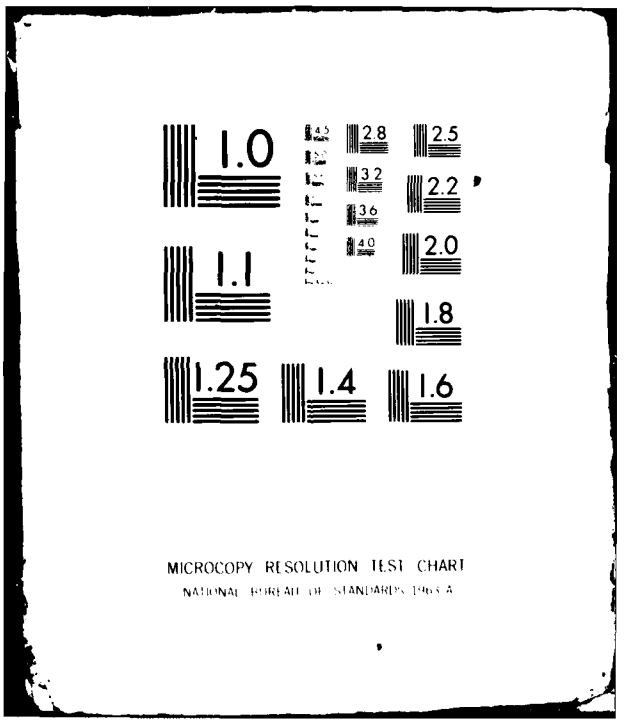
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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the Scientific Literature) may prove of value to American scientists by calling attention to current developments and to institutions and individuals engaged in these scientific efforts.

The articles are written primarily by members of the staff of ONRL and occasionally articles are prepared by, or in cooperation with, members of the

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scientific staffs of the United States Air Force's European Office of Aerospace Research and Development and the United States Army Research and Standardization Group. Articles are also contributed by visiting Stateside scientists.

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edited by T.C. Cheston and Don J. Peters

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AEROSPACE

AERODYNAMIC RESEARCH AT BRITISH AEROSPACE DYNAMICS GROUP, BRISTOL

British Aerospace was formed when the UK government nationalized British Aerospace Corporation, Hawker Siddeley Aviation, Hawker Siddeley Dynamics, and Scottish Aviation. It is organized into two main groups, Aircraft and Dynamics. The Dynamics Group was formed by consolidating the expertise of British Aircraft Corporation Guided Weapons Division and Hawker Siddeley Dynamics in 1978, resulting in a broad aerospace product range. Dynamics Group sites are located at Stevenage, Hatfield, Lostock, and Bristol in the UK.

The Bristol works, in the county of Avon, employs some 4,000 people assigned to about 30 projects funded primarily by the UK Ministry of Defence and other British Aerospace Divisions; occasionally work is undertaken for private customers. The early success of the Bristol works was founded upon the Bloodhound surface-to-air weapon system. Subsequent missile systems (e.g., Rapier and Sea Skua) have been extensively exported to European and Asian nations.

Guided-weapons programs, and their pursuant technologies, have spawned the formation of an impressive research capability at the Bristol works. Aerodynamic research is carried out in two complementary organizations: the Aerodynamics Research Department, which concentrates on theoretical work that is often followed by wind-tunnel testing; and the Aerodynamics and Performance Department which pursues problems (via modeling, tunnel testing, and flight tests) which arise out of Dynamics Group programs. A synopsis of the work of the former organization follows.

J.R. Deane of the Aerodynamics Research Department (ARD), who hosted my visit, is conducting experimental work to advance the understanding of complex, vortex-dominated flow fields around missiles. Particular emphasis is placed on the interaction between body vortices and downstream lifting surfaces, including the effect of the latter on body vortex generation, structure, and trajectory. Water tunnel tests are underway to provide a visual display of flow characteristics. The results are indicative of flow patterns which might be expected in air; compressibility and viscous effects are, of course, insignificant. These tests will be followed by quantitative, low-speed, wind-tunnel testing. A variety of models will be examined so that the effects of lifting-surface shape and position can be explored. Angles of incidence and roll are chosen to provide situations of close interaction between lifting surface and body vortices.

P.G.C. Herring, (also of ARD) has completed an experimental investigation of canard controlled missiles. A program of systematic wind-tunnel tests was carried out on a series of canard missile configurations at Mach numbers of 0.5 to 2.8. The work showed that the incremental induced rolling moment produced by a combined pitch-and-yaw deflection may be derived from data for the separately applied deflections. The experimental data was also used to evaluate Dynamics Group numerical techniques which predict normal-force and center-of-pressure characteristics.

P.L. Ostogic, (ARD) has finished modification of an existing Dynamics Group computer model to extend its applicability to include nonlinear, separated flowfields which are generated by aircraft stores in the proximity of an aircraft. After systematic wind-tunnel testing, Ostojic was able to introduce a "real flow" effect (nonlinear store loads resulting from vortex separations) into a panel-method prediction model, successfully expanding its utility beyond the normal regime of inviscid, supersonic flow.

R. Bartlett, who heads the Aerodynamics and Performance Department (APD) surveyed the work being done by his aerodynamicists. A summary of the more interesting topics follows.

C. Jell has begun an aerodynamic assessment of side intakes for air-breathing missiles, in anticipation of ramjet-powered vehicles to satisfy long-range/high-speed requirements. A thorough literature search by Jell revealed a scarcity of data on ramjet intakes in general, and almost no data for high-speed (Mach 2.0 to 5.0), high-incidence (up to 20°), multi-intake systems. Potential areas of investigation include intake coupling, boundary-layer separation and vortex generation, optional intake/control surface configurations, and force-and-moment generation by the intakes themselves.

T. Mather (APD) had initiated water-tunnel testing of noncircular missile-body sections. Initial results indicate that sharp-edged cross sections (triangular, hexagonal and semicircular) induce early flow separation, giving rise to high, nonlinear lift. Obvious advantages of noncircular cross-sections include reduced radar detectability, convenient packaging of electronic components, conformal carriage

by aircraft, and wingless, bank-to-turn control. Mather hopes to move on to precise force and moment measurements for several configurations in a wind tunnel.

Finally, R. Bartlett, the previously mentioned APD Chief, discussed his work on low-aspect-ratio-wing (less than 0.3) missile configurations. Once again wind tunnel data from several low-aspect-ratio models were employed to modify existing British Aerospace computer prediction programs. In many instances the accuracy of numerically predicting normal force, pitching moment and center-of-pressure location was increased by more than 100 percent for low-aspect-ratio-wing configurations, which tend to generate extensive wing-body interference phenomena.

Aerodynamics research at British Aerospace, Bristol, is professional and productive. Founded on a healthy mixture of sound prediction techniques and careful experimentation, the research is aimed at improving numerical prediction accuracy and applicability, and analyzing aerodynamic phenomena which are uncovered in British Aerospace studies and development programs. (Joseph A. Strada)

AUTOMATION

HOW COMPUTERS CAN HELP PHYSICIANS

"The Implementation of Algorithms in Medical Decision Making" was the subject of a 1-day meeting held by the Operational Research Society at the King's Fund Centre in London on 16 December 1980. Some 63 people paid 15 pounds each to attend. The meeting consisted basically of presentations by 6 workers in the forefront of this field: 4 physicians, 1 psychologist, and 1 mathematician. The meeting chairman was also a physician, as were the majority of the members of the audience; and it was a revelation to see how many physicians can intelligently use computer-related terminology.

The chairman, Dr. Paul Walker, an obstetrician who is now an administrator (N.E. Thames Regional Health Authority), explained that he had studied computer-aided medical decisions at a 6-week course at Harvard ("they don't do this sort of thing over here—you have to go to the States"), had the whole subject demystified, and was then appalled to discover how subjective is most clinical decision-making; he has set out to make it more rigorous.

Dr. David Spiegal-Halter (Mathematics Dept. Nottingham Univ.) explained the elements of Bayesian decision theory, the mathematical basis for most computerized decisionmaking. It consists of three parts: the decision tree, which is provided by logical analysis; the probabilities of various events, which are obtained from past data; and the utilities of various outcomes, which are obtained in a number of different ways, none entirely satisfactory. Spiegal-Halter drew the tree for a particular highly simplified example: the patient has acute abdominal pain, symptomatic of appendicitis; the physician's decision is whether to order an immediate operation, or whether to wait for developments. The situation is outlined in the decision tree of Figure 1.

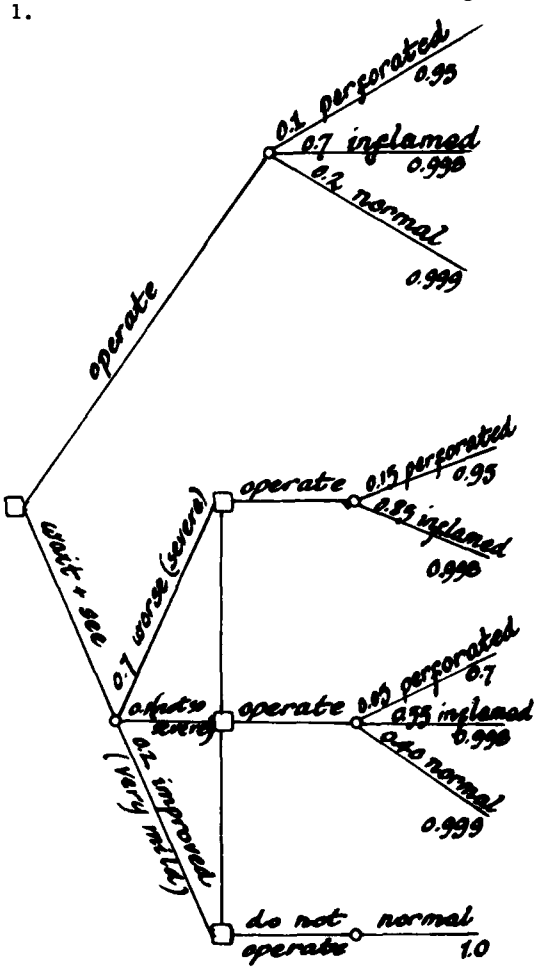

Fig 1. Decision Tree For Suspected Appendicitis

As indicated, if he decides to wait and see, there are three possibilities. The first of these is that the patient did indeed have a severe appendicitis and as a result has gotten worse; in this case, the surgeon naturally operates and may find, with the indicated probabilities, that the appendix was inflamed, or that it has already perforated. Other decisions and outcomes are as indicated in the diagram.

At the heart of the theory are "utilities" or measures of the value to the decisionmaker (DM) of various outcomes. In the simplest cases, a monetary value can be put on each outcome, and the expected monetary returns from each of the available strategies can be compared. In most cases, however, some more arbitrary utility value must be defined. In this case, the speaker chose to define the utilities as being the probabilities of survival. This normalizes the utilities to numbers between 0 (for the worst possible outcome) and 1 (for the best possible outcome), which is a desirable property of utility functions. Here, then, the utility of operating (unnecessarily) on a patient with a normal appendix is 0.999 (that is, 1-0.001), compared to 1.0 for not operating on a healthy patient.

Given the tree shown, it is possible to "fold back" (by various straightforward operations in probability theory) to evaluate the branches at the original decision point. For example, the expected value of being at the topmost round node is the value of perforation (0.95) times its probability (0.1), plus two other similar products; that is
$0.1 \times 0.95 + 0.7 \times 0.998 + 0.2 \times 0.999 = 0.9934$.
The calculations in the other branch are similar and yield 0.9932. In this case the final utilities are so similar that decision theory offers little, but of course the numbers might have been very different. Furthermore, in the real case there are many more decision points, many more alternatives at each point, and many more options. But in general, this type of analysis is relevant to most of the decisions which a clinician must make—such decisions as: which treatment should I recommend? should I refer the patient? should I do another test? should I operate? Finally, among the most important decisions are those involving cost (should we buy an expensive new piece of equipment which will improve our diagnostic capabilities?). In all such decisions there are numerous sources of uncertainty with respect not only to the diagnosis, but also, for example, to the result of a particular treatment even if the diagnosis is correct. Quite different types of decisions face DMs at various levels: from the viewpoints of the patient, the clinician, the administrator, and the politician. For example, the administrator must decide how much money to allocate to different types of illness, and the politician must decide how much money to allocate to health as distinguished from other needs. However, the meeting discussed here was restricted to clinicians' decisions.

Spiegal-Halter did spend some time on one popular method of evaluating utilities, based on the concept of a gamble to which the DM is indifferent. Suppose, for example, that a blind patient has the possibility of an operation which may cure him completely (with probability p) or may kill him (with probability $1 - p$). If we assume that the state of complete cure has utility 1, and the state of death utility 0, then by definition the utility of the state of blindness is that value of p for which the DM is indifferent as regards having and not having the operation. In other words, the DM (who may be the patient, or the physician, or anyone else) would probably prefer the operation if it were almost certain to cure the blindness, but would probably prefer a life of blindness to almost certain death on the operating table. As the probability, p, of success of the operation increases, so does the DM's preference for it; and when this preference reaches the point where the (uncertain) operation is just as valuable (to the DM) as the state of blindness, we have a numerical value of that state.

The next speaker, Robin Knill-Jones (Southern General Hospital, Glasgow) started with a remarkable quotation from Sir William Petty. In 1667, when London was suffering from the plague, Petty calculated that, for each pound that was spent transporting people out of London and caring for them for three months in order to save them from the plague, 84 pounds was returned in terms of the value of people. Certainly a forerunner of modern cost/benefit analysis!

Knill-Jones briefly discussed Bayes' theorem, a formula proposed by the Reverend Bayes two hundred years ago, which underlies (and gives its name to) Bayesian decision theory. He talked about "indicants", which may be symptoms, signs, or any other types of data which are useful in throwing light on the condition or treatment of a patient. Ordinary medical data give probabilities in the form of the probability of a particular indicant given a disease; for example, the probability that a patient who has peptic ulcer will have his pain

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relieved by antacids. But the decision tree requires the probabilities in the inverted form of the probability of a particular disease given an indicant: the probability that a patient whose pain is relieved by antacids has peptic ulcer. Bayes' theorem is a rigorous mathematical formula which converts the former to the latter.

The principal thrust of Knill-Jones' presentation was to exhort the audience to adopt computerized decisionmaking in their hospitals as he had in his. It was laced with numerical examples, such as the tremendous improvement in care of appendicitis patients when computerized analysis of the care was fed back to the physicians; namely, a reduction in perforation rate from 40% to 4%, with the rate going back up to 20% when the feedback was discontinued. He also presented details on an implemented system whereby the computer interviewed the patient at length and made up a preliminary diagnosis, which was then presented to the physician (and the computer without physicians did as well as the physicians without computers). He also described in detail a computer program called GLADYS (GLAsgow system for the diagnosis of DYSpepsia). Dyspepsia, which in America is a slightly fusty term for indigestion, appears in Britain to be a term used by physicians for a variety of gastrointestinal diseases with symptoms as widespread as nausea, chest or abdominal pain, and constipation. The computer presents to the patient a sequence of questions; for example: "which is your main problem? If vomiting, press button 1; if pain, press button 2"; and so forth. The computer is, of course, very friendly and extremely patient; many of the patients interacted with it in a surprisingly anthropomorphic fashion, talking to it or even shouting at it. The computer quickly estimates the IQ of the patient by the speed with which he/she responds to the first few questions, and then adapts to this estimate, not only by adjusting its own speed (smart people resent a computer which goes too slowly, and dull people one which goes too fast), but also by changing the complexity of the questions; for example, a dull patient might be asked to respond with a simple yes or no, while a brighter one might be given a choice between "certainly," "probably," "possibly," or "not at all." Knill-Jones reported that most of his patients actually preferred the computer to the physicians.

He also described some difficulties which one might not have anticipated. For example, Bayesian decision theory assumes that there exists a set of well-defined and mutually exclusive diseases, but in fact 23% of his patients have two diagnoses, and 7% have three; for example, a patient may have both a peptic ulcer and an irritated bowel. Furthermore, the probability of certain symptoms depends to an enormous degree on the physician who is reporting the symptom. Knill-Jones was not able to check one physician against another on the same patient (for obvious political reasons), but he did find that certain symptoms were much more likely to be reported by some consultants than by others. This was particularly true, of course, of symptoms which are fairly subjective, such as whether or not a certain organ is enlarged; in one extraordinary slide, he showed that one physician reported palpable sigmoid colon in 83% of his patients while another never reported it. One does not have to be a sophisticated statistician to recognize that there is a significant difference in the meaning of this symptom as reported by these two physicians.

The best speaker of the day was Dr. Bryan Jennett (also from Southern General Hospital, Glasgow)—best, in our opinion, because he had devised methods which were simple, practical, and useful. While the rest of the day's speakers (and indeed most of the research in the world in automated medical decision making) were concerned with diagnosis, Jennett was concerned with prognosis. In a sense, however, the two are very similar: to predict whether a patient will do well or badly is not significantly different from diagnosing his condition as mild or severe. He stressed that predictions were not useful in clinical practice (there is no great advantage in being able to tell the patient, or his family, with high confidence that he will recover with probability 0.6). More useful functions are to predict the distribution of outcomes in patient groups and to predict feature clusters associated with single outcomes.

Jennett's research has been specifically on head injuries, and his data base now includes 1800 cases. He has found it necessary to define reproducible terms describing these cases (he finds that terms commonly used by physicians in describing coma patients, such as "purposeful" and "organized," are vague, subjective, and not useful) and has defined five characteristic states: death, persistent vegetative state, severely disabled, moderately disabled, and good recovery.

To start with, Jennett has designed a remarkably simple scoring system which turns out to be a very powerful predictor in coma cases. For each of several characteristics (eyes open or closed, motor behavior, verbal behavior, etc.) he assigns a score depending on the condition. By way of example, he scores verbal behavior in the following manner: if conversation is oriented he awards 5 points, if it is confused, 4 points, if it is inappropriate, 3 points, and if it is incomprehensible, 2 points. The total score is then used for both triage and prediction. For triage, if the total score is over 10, the patient is sent to the local hospital, but if it is less than 8, the patient is rushed to the nearest emergency care center. For prediction, the applicatic of scoring is illustrated in Figure 2.

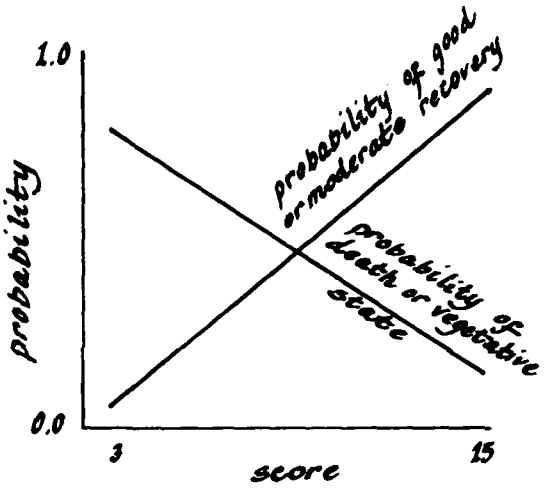

Fig 2. Prediction Probabilities For Coma Patients

Of course such a graph applies only at a particular time after the incident which created the coma; the longer one waits, the more certain the prediction becomes.

Jennett discussed the utilities (or rather, costs, which may be considered negative utilities) of various errors in prediction which must be defined if Bayesian analysis is to be performed. It is clear that an incorrect prediction of a poor outcome is more costly or less desirable than an incorrect prediction of a good outcome; that is, if the physician asserts that the patient will recover, and he then dies, that is bad, but not so bad as having the physician assert that the patient is going to die, or be a vegetable, and then having him recover. Thus, he presented his version of the costs of various errors as shown in Table 1.

Actual Outcome \ Predicted Outcome	D	V	S	M	R
D	0	0	10	50	100
V	0	0	10	50	100
S	10	10	0	50	50
M	500	500	100	0	10
R	1000	1000	100	10	0

D - dead
V - vegetative
S - severe
M - moderate
R - recovery

TABLE I. Costs of Errors in Predicting Outcomes of Coma Patients

Jennett pointed out that his data bank has many uses besides predictions. Such a bank is good for comparing one year or one location with another. It also helps in standardizing measures, and thereby improves both patient care and the effectiveness of controlled research. For example, if one predicts that a patient is going to die and is reasonably confident of that prediction, that patient should probably not be used in evaluating a prospective treatment, lest the patient's inevitable death should prejudice the treatment (this adjuration is more honored in the breach than the observance; new anticancer drugs, for example, are classically first tried on terminal patients). At the other extreme, Jennett warned against overtreating those who have received a confident prediction of recovery. Unproven therapies should be assessed on those with uncertain predictions who are most likely to benefit from treatment.

Surgeon Tony Gunn (Bangour General Hospital, West Lothian) presented another philippic aimed at those who would not install computers for clinical decision-

making in hospitals. He asserted that by use of computers, a hospital could save £250,000 ($600,000) a year and improve patient care, and proceeded to justify this in detail by showing how many patient days could be saved by improving the percentage of correct decisions in a wide variety of specified situations. For example, for Britain as a whole, 20% to 40% of all appendices removed turn out to be normal. This represents a significant waste, among other things, of money. Only about 1% of the patients whom the average GP sees have acute abdominal pain, only about one tenth of those are sent to the hospital, and only about a quarter of those are operated on. The GP sees, perhaps, two emergency appendicitis cases per year. He sends such patients to the emergency room of the hospital, where they are seen by a very junior physician or perhaps even by a medical student. In such situations 55% accuracy in diagnosis is good—many hospitals do not do that well. And yet the information is available if the patient is carefully and skillfully examined. By obtaining easily available information about tenderness, rigidity, and the like, one can diagnose perforated peptic ulcer (a diagnosis which is frequently missed in the emergency room) 99% of the time. Therefore, Gunn asserted, the use of computerized diagnosis should be compared not with the world's greatest physician, given ideal equipment and all the time in the world, but with what actually takes place in hospitals, which is deplorable.

In the question period following Gunn's presentation, someone asserted that the computer was really being used primarily to educate the physician. Gunn pointed out that the majority of the people in the world do not have a physician (i.e., the computer can be of especial help in poverty-stricken regions and third-world countries). But he also insisted that more than education was involved. The computer enforces some much needed discipline among the doctors. And he gave a lot of the credit for this improvement to the "hatred which the computer engenders among the doctors" who must work under its shadow.

Tim de Dombal, reader in clinical information science at Leeds University (the mere existence of such a title tells us a lot about how the world has changed!) also gave an emotional presentation about the necessity for more rapid and widespread adoption of computers. His final remark was "we don't have to justify their use; those who have negative laparotomy rates of 25% (i.e., 25% of the abdomens which are surgically opened show no pathology and should not have been opened) and perforation rates of 35% must justify their failure to use them." He also talked about standardizing data bases so that they could be used worldwide. He pointed out, for example, that a data base accumulated at Leeds led to a computerized system which was 91% accurate; but when that same system was applied at the U.S. Navy Hospital in San Diego, the success rate was only 54%; this rate was later increased drastically by adapting it to local data. He then asserted (and we found it hard to understand) that worldwide data bases could lead to systems of high efficiency everywhere.

In the question period, de Dombal was asked about costs. He said that his entire system is being put on a minicomputer which costs only £2,000 ($4,800) and takes up only one quarter of the time of a clerk who draws only £4,000 ($9,600) per year in salary. (These cost estimates seemed to us a bit optimistic).

The final speaker was a psychologist, Dr. John Fox (Sheffield Univ.). Fox spoke about a new field which he had invented, called "knowledge engineering," based on "artificial expertise VIA natural expertise," where VIA stands for Versatility, Intelligibility, and Accountability. He has a computer program called PSYCO (for Production SYstem COmpiler), which uses qualitative rather than quantitative information, and which he said does as well in practice as all the quantitative programs and much better than the unaided physicians. These claims were vigorously questioned at the end of his presentation.

On the whole, the day was most rewarding. Both of us had been familiar for some years with the concepts of computerized medical decisionmaking; and yet both of us were startled by the degree to which these systems have begun to be successful in practice. There were repeated selling efforts, and there was apparent bias in some of the numbers presented, which seemed overoptimistic. We were a little disappointed that more different opinions and experiences were not presented—each of the speakers apparently was working closely at Glasgow with all of the others. Nonetheless we were told about a number of internationally cooperative projects, with data bases extending over several countries in each such project. There were a couple of physicians in the audience who expressed the opinion that until the computer people learned to make their output more acceptable to physicians (who do not like to be told what a diagnosis or a prognosis is—that is the physician's business), computers were not going to be permitted; but the great majority were far more

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flexible, and seemed eager to learn and to take what advantage could be taken from the use of computers and their associated algorithms. Of course the sample is a biased one—by coming to such a meeting, the physician demonstrated a degree of liberality which may not be typical of his colleagues. Nevertheless, the breath of change could be felt clearly blowing through the conference. Most physicians have now accepted computers to handle their billing and accounting. Most hospitals have installed computers for much more than the accounting function: for keeping track of drugs and X-rays; for scheduling operating rooms; and the like.

Highly sophisticated developments of this nature have also been implemented in the US (see "Application Development system: The Software Architecture of the IBM Health Care Support/DL/1-Patient Care System" by D.J. Mishelevich and D. Van Slyke in *IBM Systems Journal*, Vol. 19, No. 4, pp. 478-504, 1980), but those systems appear to have less emphasis on clinical decisionmaking. There is no doubt in the minds of either of us that most hospitals will be making automated decisions—at least to present to the physician for his consideration and possible approval—in the comparatively near future. (Robert E. Machol and Moses A. Greenfield)

CHEMISTRY

INTERNATIONAL DYNAMIC MASS SPECTROMETRY CONFERENCE, 1980

The International Dynamic Mass Spectrometry Conference is held every three years. This year it was held in Canterbury, England, from 8-10 July 1980 and was arranged by Dr. J.F.J. Todd (Kent Univ.) with assistance from Dr. D. Price (Salford Univ.).

Approximately 50 scientists attended the meeting. About half of the participants were from Great Britain; the remainder were from Western Europe and North America. Dormitory type accomodations were provided at Rutherford College, Kent University, for those who attended. This is a modern facility and an excellent place to hold a conference of this size. Unfortunately, the almost continuous rain deterred one from visiting the many historical sites of the city of Canterbury. On the fortunate side, Todd had arranged a special tour of the Canterbury Cathedral which was most appreciated.

As the conference was relatively small, the 24 papers presented were treated sequentially over the 3 days of the meetings. The types of mass analyzers and the number of each represented in these papers were as follows: 10 quadrupole, 9 time-of-flight, 2 ion cyclotron resonance, 1 magnetic, and 2 quadrupole ion store. Several review papers were presented. Todd discussed the current status of quadrupole mass spectrometry. Dr. K. Lincoln (NASA-Ames, California) reviewed state-of-the-art techniques for signal processing from time-of-flight mass spectrometers, and Dr. K.-P. Wanczek (Univ. of Bremen, FRG) reviewed ion cyclotron resonance spectrometry.

Several rapidly evolving areas in mass spectrometry were given attention. The belief was expressed that the use of mass spectrometry for process control would become more widespread in the 1980s. Emphasis also was placed on increased reliability and more rugged packaging. (One of the most successful applications of mass spectrometry to process control is atmosphere analysis on US nuclear submarines.)

A new area which shows much promise is the linking of mass spectrometry to an inductively coupled plasma (ICP). This was shown by Dr. R.S. Houk (Iowa State Univ.) to be a useful technique for the determination of elemental concentration in solution, and it may become a substitute for spark-source mass spectrometry. The attractive features include rapid sample throughput, direct introduction of solutions, and the capability of direct, multielemental and isotopic determinations at trace and ultratrace levels. The somewhat related technique of atmospheric chemical ionization mass spectrometry was described by J.B. French (Univ. of Toronto) as a convenient means (portable instrumentation) for measuring atmospheric pollutants, and the detectability limits are in the $1:10^9$ to 10^{12} range for many compounds.

An area of current interest in mass spectrometry is double mass spectrometry (MS-MS) in which mass-selected ions are fragmented by gas collision and the subsequent fragments are mass analyzed. Dr. R. Smith (Finnigan Corp., Hemel Hemstead, UK) compared the different results observed when a collision cell and a quadrupole ion trap were used to produce the fragments. He concluded that the loss due to scattering was about 20 times greater in the case of the collision cell.

Dr. A.J.H. Boerboom (FOM Inst. for Atomic and Molecular Physics, Amsterdam) discussed a novel instrument he constructed for doing MS-MS. In his instrument the second mass spectrometer used a set of quadrupole lenses

after the analyzer magnet to disperse the ion beam on a multichannel array. By this method ions which varied in mass by a factor of four could be detected simultaneously. Boerboom gave examples of using this instrument to do MS-MS on transient species such as bacteria which were rapidly pyrolyzed.

Although this was a small meeting, we found it worthwhile. The overall quality of the presentations was excellent. In particular, there was emphasis on the frontier areas of mass spectrometry with much less routine work presented than at other meetings which these authors have attended. Formal proceedings are to be published in *Dynamic Mass Spectrometry*, Vol. 6 (Heyden & Son Ltd., London). (J.R. Wyatt, Naval Research Laboratory and K.A. Lincoln, NASA-Ames Research Center)

PHOTOCHEMISTRY AT THE CITY UNIVERSITY, LONDON

The City University (TCU) of London (not to be confused with the various colleges of the University of London) is located in central London just south of the Angel Underground Station and near Russell Square. Although TCU was established by Royal Charter relatively recently, it is not essentially a new institution. TCU is instead a direct descendant of the Northampton Polytechnic Institute which was founded in 1896. The Northampton Institute, so named because the 4th Marquess of Northampton donated the land for the institute, subsequently became in 1957 the Northampton College of Advanced Technology, and in 1966, this institution was incorporated as The City University of London. The university and its predecessors have always enjoyed an outstanding reputation in engineering, physical sciences, and ophthalmic optics but the teaching and research at TCU now also includes social science, business studies, and the arts. TCU maintains close ties with the city of London, as illustrated by the fact that the chancellor of the university is the Lord Mayor of London.

A novel feature of the academic program of TCU is the system of "sandwich courses" which may be elected by the undergraduate students. These courses combine periods of academic classroom work with alternate periods of integrated industrial training. One-third of the undergraduate students at TCU take sandwich courses which involve almost all academic areas including chemistry. (For additional information about the sandwich courses at TCU, see *ESN* 30:2-58 [1976].)

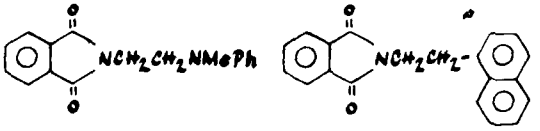
The Department of Chemistry of TCU is housed in the Connaught Building which was opened in 1932. At that time provision was made in the Connaught Building not only for chemistry, but also for watch and clockmaking, furriery, and automobile labs with some lecture rooms for general use. The building is now essentially dedicated to the Department of Chemistry and some of the labs have been modernized in the last few years.

My host for a visit to TCU was Prof. R. Stephen Davidson, who is professor of organic chemistry. Davidson has recently joined the faculty at TCU, coming from the University of Leicester where he was a reader in chemistry. Davidson has a very vigorous research program which encompasses a wide variety of areas. These research interests include: (1) the photochemistry and photophysics of excited complexes; (2) the photooxidation of amines, amino acids, and α-oxocarboxylic acids; (3) the practical aspects of organic photochemistry with application to the synthesis of macrocyclic compounds; (4) the photodegradation of polymers with particular attention to the effect of additives such as pigments; and (5) the use of photochemistry of semiconductors in solar energy conversion.

Davidson's research on the photophysics of excited complexes has recently been concerned with the formation of excited ternary complexes (complexes involving the interaction of three moieties). A particularly interesting investigation has involved a study of the quenching of the fluorescence of naphthalene in degassed cyclohexane solution by N,N,N',N'-tetraethyl-α,ω-diaminoalkanes, $Et_2N(CH_2)_nNEt_2$, where n varied from 2 to 10. The rate constants for quenching by these amines are significantly higher than those obtained with monoamines such as triethylamine. The fact that the quenching efficiencies of these diamines are much greater than those of the monoamines by more than the statistical factor of 2 has been interpreted in terms of multicollisional processes. Recent investigations in this area also include studies of the quenching of the fluorescence of Rose Bengal by bifunctional molecules such as α,ω-diaminoalkanes, α,ω-dinaphthylalkanes, and naphthylalkylamines. Results with the diamines suggest that quenching is derived from an encounter complex involving the excited state of the dye and both amino groups.

Davidson's research into photophysical processes has also included studies of intramolecular charge-transfer complexes formed by substituted phthalimides of the type shown in the structures on the following page. These compounds exhibit charge-transfer fluorescence

both at ambient temperature in fluid solution and at 77K in cyclohexane, acetonitrile, or ethanol rigid matrices. Phosphorescence from the imide and naphalene groups has also been observed. In a very recent study Davidson has utilized time-resolved fluorescence techniques to elucidate the dynamics of intramolecular charge-transfer complex formation and fluorescence.



In the area of photooxidation, Davidson and his co-worker, Dean Goodwin, have carried out a definitive study which finally resolves the controversy concerning the question of possible singlet oxygen involvement in the dye-sensitized photooxidative decarboxylation of α-oxocarboxylic acids. Using laser flash techniques and tests of solvent isotope effects, they have clearly shown, contrary to previous claims in the literature, that singlet oxygen does not play a significant role in this reaction. The kinetic data indicate that acids such as α-oxoglutaric acid react with the excited sensitizer methylene blue at a rate 100 times that of the rate with singlet oxygen. A comparison of the photooxidation rates in water and deuterium oxide gave a solvent isotope effect of only 1.04 to 1.65, values which were considered too low to be consistent with the intermediacy of singlet oxygen within this reaction. Davidson and Goodwin have also investigated the direct photooxidative decarboxylation of α-oxocarboxylic acids in deoxygenated solution. Experiments with 1-[^{14}C] and 2-[^{14}C] labeled pyruvic acid have suggested that this reaction involves bimolecular electron-transfer processes.

A major effort of Davidson's group at this time involves studies of photoelectrochemical cells which utilize a semiconductor-electrolyte interface to convert light into electrical and/or chemical energy. Davidson points out that criteria for practical utilization of solar energy with cells containing a semiconductor-electrolyte junction include: (1) absorption of light in the visible region; (2) photostability of the semiconductor; and (3) the ability to use the semiconductor in the form of a powder. He further indicated that if the conduction and valance bands of the semiconductor are such that proton reduction and hydroxide oxidation could be effected, photoelectrochemical cells using these semiconductors may be able to photoelectrolyze water. Davidson and co-workers have recently been investigating a semiconductor which shows considerable promise in that it is photostable and exhibits a band gap of 2.1 eV. The electrode is prepared by immersing platinum mesh into a suspension of mercury(II) sulfide (cinnabar) in water after which the electrode is dried by hot air. Irradiation of this electrode in a 0.1 M sodium nitrate solution is carried out with a 1.8 kW xenon lamp through a copper chloride filter solution with a maximum transmittance of 515 nm. The photo emf produced by the red HgS electrode in pH 7 (unbuffered) 0.1 M $NaNO_3$ ranges from -150 to -300 mV versus SCE depending somewhat on the history of the electrode. In an experiment in which this electrode is connected to a platinum counter electrode with a biasing potential of 0 V maintained between the two electrodes by a potentiostat, irradiation of the cinnabar electrode results in a current flow. Experiments have shown that when inert electrolytes such as sodium nitrate are employed, irradiation of the mercury sulfide electrode does not lead to dissolution of the mercury. The photocurrents with these electrodes are therefore thought to be the result of photoelectrolytic processes with water. Solubilization of the mercury does, however, occur if the electrolyte contains easily oxidizable ions such as iodide with concomitant blackening of the electrode surface. Returning the blackened electrode to a sodium nitrate electrolyte solution results again in a photostable electrode with dramatically higher photoelectrolytic currents than the untreated HgS electrode. An additional feature of the blackened electrode is that its spectral response is considerably broader than the red electrode. Investigations on the nature of the blackened material are in progress with preliminary X-ray powder photographs and optoacoustic spectra indicating the presence of some *meta*-cinnabar. Preliminary photoelectrolytic experiments with degassed sodium nitrate at pH 12 as electrolyte and a bias of >+0.2 versus SCE results in the observation of gas bubbles at both the semiconductor and platinum counter electrodes.

Davidson is also involved in studies of the photoelectrochemical reactions of pigmentary titanium dioxide using electrochemical cells with a platinum mesh electrode that has been coated with the oxide. Voltage and current measurements upon irradiation of the electrode with the high intensity xenon source have shown

that the oxide exhibits *n*-type semiconductor behavior. The voltage was found to increase linearly with the logarithm of the light intensity while an increase in temperature above ambient resulted in diminished voltage. It has been shown that electrodes of this type exhibit many similar properties to those of single crystal TiO_2 electrodes. Davidson has also investigated various chemical reactions which are effected at the pigmentary titanium dioxide electrode upon irradiation. These electrodes photocatalyze the oxidation of anions such as iodide, thiocyanate, and azide. Further, he has observed that the addition of methanol, 2-propanol, benzyl alcohol, polyethylene glycol, and polyvinyl alcohol to the electrochemical cell results in an increase in the anodic photocurrent. These results are interpreted in terms of the absorption of the alcohols on the surface of the pigment and their action as hydrogen atom donors.

In summary, Davidson has a very exciting and vigorous research program in progress at TCU. His well-equipped laboratory includes instrumentation for laser flash studies and photoacoustic spectroscopy. Further, Davidson's collaborators exhibit a genuine enthusiasm for their research problems. (A. Paul Schaap)

SECOND INTERNATIONAL SYMPOSIUM ON HOMOGENEOUS CATALYSIS

Following the First International Symposium on Homogeneous Catalysis, held at Corpus Christi, Texas at the end of 1978, the second took place September 1-3, 1980 in Düsseldorf (FRG) bringing together 350 participants from 26 countries. The symposium was organized by the Gesellschaft Deutscher Chemiker and sponsored by the Federation of European Chemical Societies.

The schedule consisted of a "keynote lecture" by Prof. Roland Pettit (Univ. of Texas), 7 plenary lectures, 44 contributed papers, and 27 poster sessions. Pettit's lecture, which was excellent, was presumably meant to set the standard for the conference. He described an original experiment aimed at finding the mechanism of the Fischer-Tropsch reaction, a transformation that produces substitutes for petroleum products from carbon monoxide and hydrogen. The experiment involved analyzing the products formed when diazomethane was passed over a heterogeneous Fischer-Tropsch catalyst along with carbon-13 labeled carbon monoxide and hydrogen, and it implied that in the reaction, CO molecules were reduced to metal carbides, then to metal-bound CH_2's, and finally coupled. The mechanism usually considered, involving carbon monoxide inserting into metal-alkyl bonds, was thereby excluded.

Other lectures that treated carbon monoxide included a scholarly one by John Bercaw (Caltech) concerning the reactions of CO with soluble permethylcyclopentadienyl complexes of zirconium and hafnium; a delightful one by Darryl Fahey (Phillips Petroleum Co.) showing that formaldehyde, even though present in undetectably small amounts, is a key intermediate that leads to all of the Fischer-Tropsch products formed by homogeneous catalysts; and a vigorous one by Tobin Marks (Northwestern Univ.) showing how the strength of the thorium oxygen bond can drive carbon monoxide molecules to combine.

Asymmetric hydrogenation was a popular topic, and lectures relating to it included one by Iwao Ojima (Sagami Research Center) on reductions of carbonyls by the addition of Si-H, followed by the replacement of Si by another H; one by John Brown (Oxford Univ.) on the mechanism of asymmetric induction; and presentations by Ivan Bernal (Houston) and Henri Brunner (Regensburg) on the structures of molecules with chiral metal atoms.

Peter Vollhardt (Univ. of California, Berkeley) presented a wealth of examples illustrating how his procedure for cyclizing molecules with triple bonds, both acetylenes and nitriles, synthesizes a variety of desirable molecules.

This was one of the first conferences at which the distinguished chemist Mark Volpin (USSR Academy of Sciences) appeared. He spoke about his work on nitrogen fixation.

The lecture by Borislav Bogdanović (Mülheim) provided a remarkable contribution to a field that is not popular because it is believed to be so well understood, that of the main group of metals. He showed how to make MgH_2 that evolves and reabsorbs hydrogen reversibly (making it a medium for energy storage) and that reacts with alkenes to give dialkylmagnesiums, materials now almost invariably made from alkyl halides, which are expensive.

Hubert Mimoun (Institut Francais du Petrole) spoke about oxidations mediated by molybdenum and palladium. Paul Krusic (Dupont) reported on esr studies of photoreactions between iron carbonyl and olefins and cyclopropanes. Manfred Mirbach (Aachen) showed how high pressures facilitate photoreactions and, by decreasing reaction temperatures, enhance selectivity. László Markó (Veszprém, Hungary) reported that the kinetics of hydroformylation (supposedly

the best understood of metal-catalyzed reactions) do not conform to the supposed mechanism.

There were two contributions concerning polymerizations. Walter Kaminsky (Univ. of Hamburg) told about his remarkably stable and effective homogeneous catalysts for ethylene polymerization prepared by combining biscyclopentadienyldimethyltitanium with $[-O-Al(CH_3)-]_n$, a so-called alumoxane. Photomicrographs he displayed showing starch and cellulose in thin coats of crystalline polyethylene were beautiful. (Properties of the starch and cellulose are supposed to remain.) I proposed that the metal-catalyzed acetylenes might induce inactive organometallic compounds to metathesize olefins. (They do. They also quench the reactions and the transformations are fanatastically stereoselective.)

Many problems remain to be solved if catalysis is to be understood and applied as it must, and plans were made to meet again in Italy in 1982, in Russia in 1984, in Japan in 1986, and in Canada in 1988. (Thomas Katz, Department of Chemistry, Columbia Univ., New York, NY)

COMPUTER SCIENCE

COMPUTER SYSTEMS LABORATORY, QUEEN MARY COLLEGE, UNIVERSITY OF LONDON (UK)

The Queen Mary College (QMC) Computer Systems Laboratory is the Computer Science (CS) and Statistics Department's response to the advent of microprocessor technology. The laboratory was established in 1974 to provide 'hands-on' access to up-to-date computing systems by staff and students. The laboratory has computing facilities that meet the needs of approximately 200 undergraduates in the department and houses about half of its academic staff, who have largely forsaken their offices for the open-plan ambience of the laboratory, attracted by its research-oriented atmosphere and the interactive aids to their work that have been developed.

"Office of The Future"

The Computer System Laboratory has been organized by Prof. George Coulouris. It contains many of the components for a prototype of the "office of the future", intended to replace conventional desks and filing cabinets with computer display screens. The reports and papers prepared by staff in the laboratory are produced without recourse to paper, pens or typewriters. Instead, the text is prepared on cathode-ray tube (CRT) screens, using a specially-designed screen editing system, and the resulting file is printed in whatever format is required for final output. With the aid of the system, the user can manipulate words, sentences and paragraphs directly on the screen, check on his spelling, and view his document in a precisely laid-out format without leaving the terminal. The difference between this approach and the conventional word-processing systems is the 'workstation' which has highly effective display systems so that the users have an information display which is at least as good as that which they are used to—usually pieces of paper on a desk. This criterion is certainly not fulfilled by the traditional computer display device. Although the automated office is just one application amongst many which require good display systems, it is an extremely demanding area which contains elements of all the currently unsolved display problems.

As one of many possible examples, consider the basic task of sitting at a desk and writing a report. In order to write that report, it is necessary continually to refer to other documents, such as previous reports, letters, and minutes. In an automated office this information would come from stored versions of those documents and could thus be viewed on a computer display. Since continual references are made to documents by the user, it is essential not to lose any of the displayed information as the user proceeds in his task. The use of several display screens, each showing a different document, could solve this problem. However, this solution is clearly uneconomical and wasteful in effort for the user to scan visually several physically separated screens. Thus, a mechanism for keeping several distinct items of information on one screen simultaneously is required.

The display area of a traditional alphanumeric visual display unit (VDU) terminal is simply a rectangular matrix of characters. One can, however, envisage a 'virtual display', which forms a rectangular subarea of the screen and which can hold information separate from that on the rest of the screen, unaffected by changes in the displayed information on any other parts of the screen (e.g., scrolling of text.) One could refer to such a rectangular subarea of the screen as a page, because of its similarity to a page of text printed on paper. To make these pages an effective means of interaction for the user, it is necessary to give them other paperlike qualities such as mobility and color, and it should be possible to pile these pages 'on top of each other' (or in front of each other if the display screen is vertical, as it usually is in display systems). If these

'pages' can then be independently addressed by the applications software, viewed as separate objects on the screen, and moved around the screen at will, then a very powerful text-manipulating display will result.

With the aid of Science Research Council grants the laboratory has developed experimental microcomputer-based systems aimed at solving the problems involved in making such facilities conveniently available to a wide range of users. One such project has resulted in the development of the QMC Text Terminal, a computer terminal designed to present an animated image of a 'desk-top' to the user. This animation enables the users to manipulate information on the screen in a manner almost as casual as their approach to the papers on a desk.

The laboratory houses both hardware and software development facilities in a central location. This has produced an environment of a type often advocated by industry proponents in which computer systems involving hardware and software components can be designed as an integrated whole by a single group of people. The laboratory has been able to develop and evaluate a wide range of ideas for the application of microprocessors and other large-scale integrated-circuit chips.

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The fallout has been considerable. The department has provided students with access to dedicated interactive terminals on a scale sufficient to satisfy teaching needs. Undergraduates, postgraduates and staff work at 50 terminals attached to the laboratory's three PDP11 computers, using state-of-the-art software that has emerged from the work of the laboratory and similar laboratories around the world. (They also have immediate access to many of the 200 papers, books, and reports stored in the computer.) The microcomputer system developed in the laboratory has been named Iota and has been widely adopted within QMC. It is presently being installed in many departments. Students in CS have been able to participate in many development projects based on these microcomputers, and the Iota system is the basis for a low-cost terminal controller.

Laboratory System

The laboratory normally houses 8 academic staff, 3-4 research staff, 5 technical staff, and up to 8 research students. The computer equipment includes three UNIX time-sharing systems, running on:
(1) PDP 11/70 (512k bytes, 2x80 Mbytes, magnetic tape, printer, 30 Hazeltine 1510 VDU's at 9600 baud)
(2) PDP 11/40 (160k bytes, 2x300 Mbyte discs, printer, 12 VDU's at 9600 baud)
(3) PDP 11/34 (89k words, 2x10 Mbyte discs, printer, 6 VDU's, raster graphics display, Diablo Hitype printer).

In addition, there are hardware development facilities and a number of microcomputers, some of which were developed in the laboratory, with appropriate software development facilities supported from the Unix systems. The PDP 11/70 is expected to be connected to the VAX780 in the near future.

Research Activities

Under the leadership of Coulouris, work has been pursued at many levels and in most areas of information technology. Much of the research effort in the laboratory is directed at understanding the problems of designing computer systems that are both simple and effective tools for interactive information processing. The design of such systems is seen as an exercise in the formulation and implementation of adequate and consistent "user's models". Work in this area is expected to result in the development of new principles and techniques for the design of personal information processing systems.

Understanding of the problems is achieved by the construction and use of state-of-the-art systems. A conscious effort has been made to construct realistic application systems: program development environments, editing systems, documentation aids, interactive graphical aids, ordering and accounting suites, etc., which have been in everyday use in the laboratory. The design, development and use of these systems has, in turn, stimulated work in enhanced methods of interaction - terminal design, advanced text and graphics systems, etc. New techniques have been developed in display design for office workstations, in text editing, and in software structures for personal information systems.

The design of high-quality raster graphics displays is now the subject of a specific project. Other areas of major activity include the design and implementation of concurrent programming languages and systems, the design of high-level machine architectures suitable for distributed processing, and the development of low-cost information networks.

Support for these research activities has come principally from the Science Research Council, with additional significant contributions from industrial and other research contracts.

The research done in the laboratory has generated considerable industrial interest, resulting in strong links with many of the companies that are currently applying microelectronics. One early example of this that has now resulted in a specific product is ICL's recently announced Content-addressable File Store, which was originally conceived by the team in the laboratory. Industrial interest in the work is now especially high as the awareness of microelectronics and its impact on the office increases. Visitors from industry are to be found in the laboratory almost daily, and joint research projects or consultancy agreements have been established with several companies including ICL, Inmos, Logica, Nexos and Philips.

College Is For Teaching!

Someone once observed cynically about the US academia: university is an institution for learning while college is for teaching; and those who cannot teach do research. This is not the case at Queen Mary College. Project work undertaken by undergraduate students has included the development of computer networks, operating systems, compilers and text editors; and a model railway, a speech output device and a music synthesizer have been successfully connected to the laboratory's computers by undergraduates. In this author's opinion, QMC computer science undergraduates are more experienced computer practitioners when they graduate than most of the American computer science majors with master's degrees. In general, this is due to lack of hands-on experience by students and esoteric research interests of computer science faculties in the US. (Y.S. Wu)

ENGINEERING

ANTENNAS AND RELATED TOPICS FROM SIEMENS A.G. AND A.E.G. TELEFUNKEN

Much of Europe's electronics research and development work is carried out by industry and has, perhaps, less visibility than university work—until it hits the market in applied realizations. I visited two of Germany's industrial giants, Siemens A.G. in Munich and A.E.G. Telefunken in nearby Ulm, to hear about their work on microwave antennas and related topics.

Siemens is one of the world's largest electrical engineering companies. In 1977/78 its sales totaled $15 billion, about half of which came from outside Germany. Siemens has companies throughout Germany and in 128 countries, and altogether it employs a total of 322,000 people. In Germany, Siemens is the largest employer after the post office and the railroads. Its broad spectrum of products ranges from electric motors to power stations, telephones, computers, radar, and medical electronics. The company further provides consultation, planning, and maintenance services. Siemens puts much emphasis on research and development for which it spends well over $1 billion per year. At the same time, it spends $200 million on personnel training and education. It claims that 40% of the equipment and systems that it offers today were developed within the last 5 years.

The Siemens plant I visited was in Munich. It seemed like a small, self-contained city and employed over 20,000 people. The chief of the Antenna Department, Mr. Anton Brunner, was unfortunately away. I first saw Mr. Erwin Kress, who gave me an overview of radar antennas that had been developed and that are in production. A family of mobile pulse Doppler radars (MPDR) has been developed; the majority of these radars are equipped with reflector type antennas. The series includes a 28 dB L-band antenna with a nominal 4°-wide beam in azimuth and a cosec^2 beam in elevation, mounted on a cherry picker-type carrier; a 31 dB rotating search system, also at L-band; and various others at different bands. Of special interest was the MPDR 18/X for the detection of low-flying aircraft and for use on land or at sea. It uses X-band and in one configuration, consists of a reflector energized from a 5-feed-horn system that can give an elevation transmit-receive cosec^2 beam, and 5 additional stacked vertical receive beams, each about 10° wide. The azimuth beam-width is 1°.

Antennas were designed at the Munich facility but produced mainly at another location, in Friedrichshafen. At this time the group is investigating the convenient near-field technique of antenna measurements in which the antenna aperture field is examined and the far field is calculated (*ESN* 35-1:12 [1981]).

Mr. Reinhart Bradow discussed Siemens' phased-array work. An initial small experimental phased-array system with 256 elements, called VM (Versuchs Model) 256, was built at S-band. It is in the form of a hexagonal phased-array lens in which the elements on the

2 sides (collectors and radiators) are formed by printed folded dipoles. Electronic phase shifters inside the lens modify the aperture phase front to collimate and steer the beam. The dipoles are arranged in a square matrix, separated by about half a wavelength to avoid grating lobes. The dipoles on the 2 surfaces are connected by phase shifters which have 3 bits and use diodes as active elements. The present configuration is rather lossy. The lens is fed with a diagonal horn with horizontal polarization.

The system is purely experimental and still being evaluated. In the meantime, a large phased array with 2,580 elements is being designed. It will again be in the form of a phased-array lens, but this time it will be elliptical in shape. Aperture illumination will be achieved with a very carefully designed multimode horn complex giving vertical polarization and separately optimized monopulse sum and difference patterns. The sum pattern aims at a 14 dB taper and the expected directivity index is nominally 39 dB. Collectors and radiators on the surface of the lens will again consist of a square matrix of folded dipoles spaced by about half a wavelength. The final array gain with scanning follows the element pattern. A measure of the element pattern therefore shows up undesirable effects that may exist due to mismatches or surface resonances and that are manifested by low-gain dips. A small group of elements (13 × 4) is therefore being assembled at this time to measure the element pattern (of 1 element, in the presence of the mutually-coupled others). The phase shifter is being designed, with diodes, as a printed circuit on an alumina substrate and will have 3 bits. Phase shift calculations will be carried out separately for azimuth and elevation steering (rows and columns) in a central computer, and will be added at each element by a separate circuit giving modulo 2 π. This will enable the wiring to follow rows and columns rather than requiring a separate pair of wires for each element. The plan is to build a system, albeit at this time half-size, with 1,290 elements, in an elliptical configuration. Rather ambitiously, it is expected that the whole system will be assembled and ready for tests by the end of 1981. Funding is from the German Ministry of Defence (MOD), which will carry out tests in its own test station near Nürnberg. The tests will probably be on a test range with a turntable but at this time, near-field measurements are being considered as a possible alternative.

Mr. Wolfgang Rebhan described work on antennas for ground stations and satellites. Many different types of large parabolic reflectors have been designed and constructed, mainly for the 4 to 6 GHz band, with reflectors exceeding 100 ft in diameter. A station may cost about $10 million; therefore, a considerable amount of effort goes into the design. In Raisting, 40 km south of Munich, there is a quiet, hollow terrain that shields the area from much man-made noise. Seven antennas built by Siemens are situated there that are being used with satellites by the German post office, and for research. Siemens believes that the best design is one that uses a near-field Cassagranian system. A Cassagranian reflector system makes use of a large reflector and of at least 1 subreflector. Usually, the primary feed is in a hole of the large reflector, illuminating the subreflector which can be closer or further than the focus of the large reflector. In the near-field Cassagranian system, the subreflector is closer than the focus, and it is claimed that greater band-width is obtained this way. The development work at Siemens is carried out with scaled models and includes a measurement of amplitude and phase of the field at the subreflector from which its optimum shape is then calculated.

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The large reflector need not be exactly parabolic—degrees of freedom exist in shaping the 2 reflectors which can be used for controlling the amplitude as well as phase distribution, leading to more efficient systems with low side lobes. At this time, efficiencies of 75 to 80% are achieved. This includes all feed losses. The antenna panels are usually made of aluminum and the strength members are made of steel. The reflectors can be pointed in any direction and microwave rotating joints are required for this. A 4-mirror subreflector system is possible (and seems to be favored in Japan) in which the mirrors are positioned so as to act like free-space rotating joints, allowing rotation of the system in both planes without changing the field distribution. Siemens prefers a 2-mirror subreflector system which is much easier to adjust and the company believes that it is highly competitive with the Japanese system. Siemens has designed such a system operating from 3.7 to 4.6 GHz.

The feed is a low-loss, higher mode corrugated horn giving circular polarization or polarization diversity which may be used adaptively. Cross-polarization peaks have been measured at -26 dB.

Research work on satellite antennas is sponsored by the Ministry for Research and Technology. There is a requirement for satellite TV antennas giving footprints of various, specified shapes. Antenna configurations, reflectors, and lenses have been studied with various aperture distributions and excited by multiple feeds or single multimode feeds. Siemens is clearly very active in the the antenna field.

A.E.G. Telefunken's Radar Division is in Ulm, close to Munich. Ulm lies on the Danube and is famous for its cathedral. With branches throughout Germany, Telefunken is second only to Siemens as an electric manufacturer, employs 160,000 people, and has yearly sales of about $7 billion. The name A.E.G. Telefunken freely translates into General Electric Company Telecommunications, but the company's products include all forms of power and industrial engineering equipment and appliances as well as all types of electronics.

At the Ulm plant, I saw Dip. Ing. Werner Gerlitzki, head of the Systems Engineering Department, and Dip. Ing. Wolf-Dietrich Tretter, chief of the Planning Department. They gave the number of employees at Ulm as about 10,000 and said that yearly sales totaled about $600 million. They described the work of the radar division which, by itself, employs 660 people and accounts for about $125 million in sales. Approximately 85% of the division's output is utilized in FRG, most of the remaining 15% is exported to NATO countries. About 80% of the output is for the military.

Gerlitzki discussed a new, mobile, 3-D phased-array radar, TRMS (Telefunken radar mobile search) which operates at C-band using a Hughes Aircraft Corporation flat-plate array antenna. It has phase shifters in every row giving electronically-controlled scanning of a nominally 1° beam in the vertical plane (-15° to +30°). The horizontal plane is scanned mechanically by rotation of the antenna, or by a reciprocating sector scanning motion. The antenna, which can be elevated to 12 m, folds flat on the roof of a van. The van contains the coherence transmitter (crossed-field amplifier), a receiver with side-lobe surpression and MTI, signal processing, and IFF. A second van which carries computers and displays is used for evaluation.

The antenna has polarization diversity, and a circular-polarization, rain-rejection mode can be used. This mode, in fact, is much used in Europe. It rejects the clean, polarization symmetric, target returns from rain, but accepts reflections from targets that, like aircraft, have a polarization preference.

A preproduction model of TRMS is scheduled for mid-1981, with production expected to start in 1984 for the Air Force, and to continue through 1994 with deliveries to all 3 services.

Future TRMS antenna systems are being studied including a possible version at S-band. Each row of the phased array may contain its own transmitter and receiver. The transmitter, it is argued, is likely to be a solid-state amplifier with a low-power phase shifter at its input side. The receiver will have a digital output, and phase shifting will be achieved by complex multiplication with a phase shifted signal. The receiver beam-former may be designed to give 3 stacked beams, or it may have an adaptive system that, for example, broadens the beam-width several fold. Development is underway on PIN-diode phase shifters, power amplifiers, and transistors giving 25 W at S-band. Aperture matching is studied by an examination of the array element pattern as previously described. Polarization diversity is believed to be an essential feature and will be retained.

An antenna designed by Texas Instruments is being built by Telefunken for the nose of the Tornado aircraft system which will be used by NATO countries. It is a flat plate slotted waveguide array operating in the 18 GHz band. The waveguide system is milled out of solid stock and a cover plate containing the slots is cemented on. Surprisingly (to me), this works well and has low losses. The antenna is elliptical in shape, 42 × 80 cm, and gives monopulse (sum and difference patterns) with low side lobes.

German harbors are fairly far inland and are reached through river mouths which are well congested with shipping traffic. Telefunken has developed a sea-clutter-resistant coastal/harbor radar for effective shipping control of these channels, including all conditions of poor visibility. Phase I of the program was accomplished with the installation of the system consisting of a chain of radar stations along the river Jade, which includes Wilhelmshaven. The radars operate at X-band (70 KW peak), typically have a 24-km range, and obtain very fine angle resolution with a line-array antenna giving an

0.35° azimuth beam-width (60 m at 10 km), and range resolution with a 100 or 250 nsecs pulse, all this so that 2 ships in proximity to each other can be resolved. The antenna was designed by Telefunken. It consists of a double-feed system, one for each polarization, with waveguide 1:6 power dividers followed by 2 sets of 1:8 tri-plate power dividers coupling to dually-polarizable, round waveguide radiators spaced over a 7-m aperture. The array feeds a cylindrical reflector shaped in the vertical plane to give a cosec^2 beam. The complete antenna is contained in a GRP (glass-reinforced plastic) radome and rotates typically at 17 rpm.

Sea-clutter rejection is obtained by frequency diversity with 2 closely adjacent pulses generated by 2 separate magnetrons with 200 MHz separation, and by polarization diversity with sequential pulse trains having orthogonal polarization.

In Phase II of the program, more stations will be constructed to control the long approaches along the Weser (Bremerhaven) and Elbe (Hamburg) and processing refinements will be added.

Telefunken has developed a mine-sweeping system, "TROIKA," (Mine Sweeping System HL 351) which was described to me. The system uses 3 unmanned vessels deployed and controlled by radio from an anchored, manned "lead" boat. The unmanned vessels, which sweep carefully controlled sectors, are furnished with Krupp-Atlas mine detection sonars and carry equipment for the detonation of acoustic and magnetic mines. They are built to be shock-resistant and can survive even close explosions. Each unmanned vessel carries a Luneburg lens reflector. The radar system on the lead boat uses a sector scan. It has the same type of antenna as that which was developed for the coastal and harbor control radar giving an 0.35°-wide beam. A complete system has been built and undoubtedly has been evaluated by now.

My visits to the two industrial giants described in the preceding paragraphs made it very clear to me that both Telefunken and Siemens are very active companies, well equipped and well prepared to take the lead in research and development efforts. (T.C. Cheston)

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MILITARY MICROWAVES '80 CONFERENCE IN LONDON

The Military Microwave '80 Conference was held in the Cunard International Hotel in Hammersmith, London, on 22-24 October. It was an excellent conference and well attended, with more than 500 people registered. The conference was organized by Microwave and Exhibition Publishers Ltd. and chaired by Dr. John Clarke, from the Royal Signals and Radar Establishment in Malvern. There were 94 papers delivered in 21 sessions with usually 2 sessions running simultaneously. Each session had both a chairman and a session manager at the high table. The papers were generally very well presented, with good, readable visual aids that were neither too cluttered nor filled with endless equations.

The first session, "Active Electronic Countermeasures" cautiously steered around classified material. The electronic countermeasure area is one in which wide bandwidth is required so as to be able to match the radiated enemy frequencies. The first paper, "Microstrip and Triplate Rotman Lenses," was by A.Y. Niazi, M.S. Smith, and D.E.N. Davies (Univ. College, London). It was presented by Niazi and Davies. The authors described various configurations of microwave Rotman lenses using printed circuit techniques. The Rotman lens satisfies the Abbe sine condition allowing very-wide-angle scanning with low coma (odd order) aberrations. Spherical aberrations (even order) can be kept small by careful refocusing. The lens has very wide bandwidth and is normally confined to one plane. Various forms have been built and tested with wide-band matching and multiple-beam formation.

W.D. Cornish (Defence Research Establishment, Ottawa, Ontario, Canada) presented a paper, "Microwave Frequency Dividers—Devices and Applications," in which he described the fundamental new dividing devices that make use of subharmonic generation for accurate frequency division. Two octaves of bandwidth can be obtained. No local oscillators are required, and the signal is truly divided, not band-shifted. Each successive stage of division halves the bandwidth of the signal so that the wide-band input can be mapped into a narrow-band output while the percentage bandwidth stays the same. Cornish described an experimental system which compresses a 125 MHz to 16 GHz input in octave bands to a 125 to 250 MHz band followed by digitization for countermeasure application.

"System Performance Trade-offs—Responsive and Repeater Jammers" was the descriptive title of a paper given by M. Pett, (M.E.L., Crawley, UK). He reviewed the subject of the title and also discussed

current technology trends. John B. Sparno (Loral Corp., New York) discussed the US advanced electronic warfare system, Rapport, in his paper, "Rapport Tactical Self-Protection Systems Design". The design philosophy was described as being aimed at cost effective system integration to avoid duplication, computer control to adapt to the environment, programmable power management, distributed antennas, and packaging for easy installation.

Several sessions were devoted to the discussion of millimeter wave systems and components. In the one entitled "MM-Wave Circuit Technology," the point was made that presently good performance was being achieved in many different applications and that emphasis was shifting to cheap volume production. M. Inggs (E.R.A. Technology Ltd., Leatherhead, UK) co-authored a paper with N. Williams entitled "Dielectric Waveguide Technology and its Implications for MM Wave Integrated Circuits and Antennas." Inggs, who presented the paper, discussed thick-film printing of low-loss dielectric waveguides for both active and passive components, which made low-cost volume production possible. He showed applications of the waveguides as feed networks for array antennas with either printed circuit radiators or dielectric rods (polyrods).

Many components are now being designed on E-plane circuits which consist of a substrate that centrally spans the broad walls of a waveguide (the E-plane). Included in that family are the various forms of fin-line and microstrip lines. R.N. Bates and M.D. Coleman (Philips Research Laboratories, Surrey, UK) described mixers, switches, and other components designed with this technique for frequencies up to 100 GHz. The paper, ("Millimetre Wave E-Plane MICs for use up to 100 GHz", was presented by Bates. He also showed a picture of a 35 GHz radar assembled from such components. The radar included a printed planar array antenna. A paper from Germany described work on similar, fin-line-like devices and discussed PIN attenuators, switches, directional couplers, and wide-band mixers. Typical mixer performance showed a conversion loss of about 7 dB (±1.5 dB) over the band 26.5 to 40 GHz. The paper, "A Survey of Planar Integrated MM-Wave Components," was presented by H. Meinel and co-authored by B. Adelseck and H. Gallsen (A.E.G.-Telefunken, Ulm, FRG). In the last paper of this session, "Hexaferrite Components—Tunability at Millimetre-Waves," by M. Lemke and W. Hoppe (Philips GmbH Forschungslaboratorium Hamburg, FRG), Lemke outlined the difficulties of electronic tuning using veractors, or YIGs, at the higher end of the millimeter wave spectrum and described how it could be achieved with small single-crystal barium-ferrite spheres. The spheres were coupled to crossed waveguides for narrow band (0.5%) filters tunable over 25 GHz (52 to 87 GHz). Similar spheres were used to tune a 65 GHz Gunn-diode oscillator over a 5% band. The FM-noise from that oscillator was about 25 dB lower than that of a state-of-the-art tunable Impatt-oscillator.

Further interest in millimeter waves was shown by a session on millimeter-wave targets, clutter, and propagation. In an interesting paper entitled "94 GHz Radar Propagation in Realistic Battlefield Environment," by D. Zur Heiden, V. Kloevekorn, and U. Raudonat (Standard Elektrik Lorenz AG, Stuttgart), Heiden described an investigation into millimeter wave radar performance under conditions of actual artillery bombardment where rounds of high explosive and white phosphorus (smoke) were being fired at an impact area. A 94 GHz radar was positioned to look across that area at a reference corner reflector target at a distance of about 2 km. The radar antenna gave a beamwidth of 0.7°, and under clear conditions the target gave a signal excess of 15 dB. A single impact in front of the target gave an attenuation exceeding 15 dB for less than 1 second and a backscatter cross section of 14 m^2 for 1.6 seconds on the average. After a few seconds all effects had disappeared. For comparison, a laser system in the same circumstances would be out of commission for periods of up to half an hour. During the heaviest density of firing, 4.4 rounds/sec/km, the reference target could be detected more than 90% of the time.

Another session treated millimeter waves in relation to radiometers. There were two papers from Germany's DFVLR, Oberpfaffenhofen. The first, by K. Grüner and B. Aumiller, was entitled "Airborne Measurements with a Sensitive High Resolution 90 GHz Radiometer." Grüner, who presented the paper, described a new, sensitive, 90 GHz radiometer with a cooled front end. A data rate of 1,500 samples per second was achieved and gave a temperature resolution of 1K. The antenna system had a high-speed swinging parabolic reflector scanning a 1° beam. The system was mounted in an aircraft, and Grüner showed quick-look TV-type pictures in which cars and trucks were clearly visible on highways and in parking areas. The second paper from DFVLR, by R.H. Dittel, was titled "Automatic Identification of Objects and Surfaces from Passive Multispectral Microwave Data." Dittel described radiometric measurements at 11, 32, and 90 GHz and proposed an automatic classi-

fication algorithm for detecting clusters. He noted that tanks can be seen in a field where they reflect the background temperature of the sky, but become invisible if sheltered by (hot) trees which they then reflect in a similar manner.

Two other papers in that session (from E.M.I. Electronics Ltd., UK, and Georgia Inst. of Technology, Atlanta), discussed millimeter radiometry imaging. The final paper of the session (from the Philips Research Laboratories, Redhill, UK) discussed low cost millimeter sensors.

Millimeter waves were also discussed in two papers presented during a special session devoted to antennas. In the first, "Millimetre Wave Antennas," by N. Williams and N.A. Adatia (E.R.A. Technology Ltd., Leatherhead, UK), Williams surveyed the present antenna technology. He then went on to say that he believed polarization diversity, perhaps used adaptively, would be helpful in future efforts aimed at target detection and identification. In the second paper, "Millimetric Aerials for Full Illumination Radars," by M. Carter (E.M.I. Electronics Ltd., Wells, UK), Carter described efforts at E.M.I. to develop antennas for a radar modeling facility. The antennas, which covered from 30 to 300 GHz, were designed to handle all types of polarization and included many different types: horns, scalar horns, lenses, parabolic reflectors, and others. Carter presented a second paper during an interesting session on array antennas in which he and E.R. Cashen gave results obtained with printed circuit linear arrays in a paper, "Linear Arrays for Centrimetric and Millimetric Radars." They used a serpent array which was formed by a sinusoidal printed line that radiated with the E-vector transverse to the length of the line, and a parasitic dipole array.

Printed microstrip antenna work was also reported by J.R. James, P.S. Hall and C. Wood (Royal Military College of Science, Shrivenham, UK) in their paper, "Recent Developments and Trends in Microstrip Antennas," presented by James. Their work has previously been reported in these pages (*ESN* 34-3:117 [1980]). They have developed printed circuit radiators of various types, including end-fed arrays and "patch" radiators. Their radiating elements were mainly end-fed in a simple way by printed circuits on the same surface rather than from below by penetration of the ground plane, and they lack wide bandwidth and high efficiency.

Phased arrays were also included in the session on array antennas and were discussed by R.J. Mailloux (Rome Air Development Center) in his paper "Progress in Phased Array Technology." Mailloux emphasized the need for low side lobes and null-steering and described various antenna systems, including the SEASAT microstrip array. He also presented an interesting concept of exciting overlapping subarrays on a lens antenna aperture. Mailloux achieved this with an array in the focal region that was energized by a Butler matrix or multiple beam lens and he obtained wide band scanning properties.

A digital beam forming system was described by H. Devred in a paper written jointly with J. Roger (Thomson-CSF, Paris, France) and entitled, "Experimental Digital Beam Forming Antenna." They used a "partial sum" beam forming approach, which required rapid sampling of the aperture. (This is easily achieved with acoustic arrays where the signal frequency is low.) They achieved it at S-band by first heterodyning to a lower frequency and then going to a matched filter using surface acoustic wave or charge coupled devices. The beam-forming weight computations were then carried out with a digital computer.

There were many papers from the US which covered a broad spectrum of subjects and were well received. They have been substantially omitted in this report, since the reader is more likely to be familiar with the work. The presentations at this conference were primarily from industry or research establishments, and were uniformly well prepared and presented. An exhibition was held at the same time with almost 250 companies being represented. (T.C. Cheston)

MATERIALS SCIENCE

COMPOSITES IV

The "all-composite" aircraft is virtually a reality, at least, so it is claimed (*ESN* 34-11:517 [1980]). One example is the AV8B V/STOL (vertical and short takeoff and landing) aircraft on which the fuselage and wing structure will be primarily constructed of resin-matrix, graphite and glass-fiber composites. This extensive replacement of metal by composite materials is a culmination of years of research and engineering design. However, to many of us who have worked in this field, it comes as something of a surprise to learn that the all-composite aircraft was almost a reality during WWII.

When France was invaded and occupied by the Germans in 1940, the UK was cut off from its major supply of bauxite, the principal source of aluminum for

aircraft. In the frantic search for an alternate material, Aero Research Ltd. (Duxford, UK) took on a project to build a prototype Spitfire fuselage using a phenolic resin reinforced with flax fiber. To build the prototype fuselage, sheets of resin-impregnated fiber were overlayed, with the fiber in alternate orthogonal directions, i.e., a 0-90° layup. The laminates were cured by heat and pressure. There was no attempt to build a hybrid fuselage, part composite and part aluminum. The entire structure was built from the flax-resin composite, including the circumferential and longitudinal frame members and the covering skin. Moreover, there was no attempt to use adhesives. The entire prototype structure was riveted together despite the considerable experience that already existed with phenolic resin adhesives. Also, there was no attempt to redesign the fuselage structure to allow for the anisotropy of the strength and stiffness of the laminate. The rationale for using rivets and not redesigning the fuselage was that the composite should replace aluminum on the production line with a minimum of interruption to production.

The need for this composite fuselage never materialized. Spitfires continued to be built from aluminum for the remainder of the war. Nonetheless, preliminary tests at the Royal Aircraft Establishment (Farnborough, UK) indicated that the flax-phenolic material was a viable alternative, and had it succeeded in replacing aluminum the use of composites in aerospace construction might be much further advanced than it is today. After the war Aerospace Research Ltd. continued its work in the field of composites and today it is part of Ciba-Geigy Ltd., Plastics and Adhesives Division (Duxford).

At the close of the war the aircraft industry in the UK was crippled but still viable. On the continent it was almost entirely destroyed. One of the companies, Vokker-VFW NV in the Netherlands, was essentially wiped out in 1945 and began to rebuild with a staff of less than 10 technical people. Moreover, the company had been left out of the steep technical gradient that had occurred in aircraft development in the US and UK. During the early days of postwar reconstruction, Vokker built buses to help ease the horrific transportation problem that existed on the continent. Vokker's first venture back into building aircraft began with the repair of airplanes and continued with the development of small planes for pilot training (the S-12). In 1951 the company began the design of the F-27, a 2-engine turboprop aircraft which went into production in 1955. In 1968 Vokker entered the jet age with the 2-engine F-28 jet transport. Both craft are still in production today for short- to medium-range service and are highly regarded for their economical operation, reliability, and durability. The F-27 has logged well over 15 million hours flying in virtually every part of the world. Much of this reputation has come about from innovative design, skillful craftsmanship, and meticulous quality control.

Vokker was one of the first aircraft manufacturers to make extensive use of metal-to-metal adhesive bonding. The decision to use adhesives instead of conventional riveting was due largely to Dr. R.J. Schliekelmann, who came to Vokker at the close of the war after being released from a Nazi concentration camp. Even before the F-27 was being designed, Schliekelmann argued for the use of adhesives (at that time phenolic resins) in the S-12 training aircraft. His enthusiasm for adhesive bonding was fired largely by his friendship with the Dutch-born Dr. N.A. deBruyne at Aero Research Ltd. After very promising laboratory tests an entire wing of an S-12 trainer was fabricated using adhesive bonds and was flight tested. The results were so encouraging that the fabrication of the F-27 was evolved around this then-novel construction technique. Since then, Schliekelmann has maintained a continuous program of research and testing on adhesive bonds with emphasis on stress-corrosion resistance. Adhesive bonding technology has undergone some major changes since the days of the S-12 trainer, notably, the near-complete replacement of phenolics by epoxy-base adhesives and the introduction of new aluminum alloys. Nonetheless, Schliekelmann and Vokker have remained in the forefront of advances in aerospace adhesive bonding.

The majority of the advances in bonding technology in recent years have been made at the research and development facilities of the larger aircraft manufacturers, especially those in the US. Ordinarily a small company such as Vokker would not have access to this usually proprietary information. However, Schliekelmann had developed the Vokker Bond Tester, a nondestructive test (NDT) method for detecting areas of debonding based on ultrasonic resonance-impedance principles. Until very recently, the Vokker Bond Tester was the only instrument available for adhesive bond NDT and was used throughout the industry. This instrument gave Schliekelmann entry to the aircraft R&D centers and access to new developments as they came along. He has also been able to judge the quality of

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aerospace bonding over the years. In his opinion, most of the present bonding practice he has seen has been second rate; it has lacked the dedication to detail he feels is essential to build a durable aircraft. In this writer's opinion, this is something of a strong statement, but not without some truth.

Vokker is developing a new aircraft, the F-29, a 138-seat short- to medium-haul transport which will be similar to the F-28 but will have improved aircraft fuel efficiency and performance. Plans call for a prototype in 1983 and for a final decision on whether to go into production to be made in 1985. This decision will be based largely on Vokker's ability to bring out an airplane showing marked differences in operating costs as compared to the airplanes of today. Fuel efficiency means a reduction in structural weight which will be done in part by the use of organic matrix composites for door panels, cabin furnishings and cargo compartment lining, landing gear doors, and fixed wing leading edges. Weight-saving is expected to be in the neighborhood of 1,000 pounds.

As for Schliekelmann, he has retired from Vokker largely because of ill health brought about by his internment in a concentration camp. He will be missed by the airplane industry because of his expertise in structural adhesive bonding, and also for his dedication to quality workmanship. (Willard D. Bascom)

POLYMER SCIENCE IN ITALY

During the 1960s Italy held a very prominent place in polymer research and development. A large measure of this prominence was due to Prof. G. Natta at the Milan Polytechnic. Natta headed a large team of scientists and engineers engaged in the synthesis, characterization, mechanical testing, and commercialization of a range of polymers—mostly polyolefins. The enormous contributions of Natta and his co-workers were an outgrowth of Natta's work with G. Ziegler and the use of Ziegler catalysts, 2-component organometallic complexes, for which Natta and Ziegler shared the Nobel Prize in chemistry in 1963. Natta's staff included 20 people at the Polytechnic, and 60 people in industry, mostly at Montedison (Milan, formerly Montecantini Edison). Unfortunately, illness overtook Natta and as early as 1971 the activities at Milan began to wane.

One of Natta's co-workers was Prof. G. Zerbi. I talked with Zerbi at the Milan Polytechnic where he is on the staff of the Institute of Macromolecular Chemistry (IMC, part of the Italian government Consiglio Nazionale delle Ricerche, CNR). Natta had been instrumental in forming the IMC. When he could no longer serve as its director he was succeeded by Zerbi, who held the position until 1978. At that time Zerbi went to the Chemistry Institute at the University of Trieste, but very recently he has begun to move his activities back to the IMC at the polytechnic where he hopes to be granted a university chair in macromolecular science. This move was prompted in part by the greater number of graduate students in Milan and its close proximity to industry and to possible sources of funding. He must obtain a chair at the university in Milan in order to be eligible for grants from the CNR, the principal source of research funds in Italy. The CNR determines the discipline in which a chair is established and at which university it will be located. This policy has helped to distribute and equalize educational and research talent throughout Italy. However, it contributed to the dispersion of Natta's staff and has made it impossible to establish scientific centers of excellence.

Zerbi explained some of the difficulties that exist in education and research in Italy's universities and the measures the government is taking to correct these problems. Upon leaving high school at about the age of 19, a student enters the university and takes a highly specialized curriculum. The entire program takes 5 years, with the last 2 spent doing thesis research. The graduate receives a "Doctor's" degree which is not deemed equal to a PhD degree given in other parts of Europe. The government has passed laws, to come into effect in 1981, which will extend the higher education program by 3 years and establish BS, MS, and PhD programs. Some of the university departments already have taken measures to upgrade graduate education. Zerbi established a program by which doctoral graduates take an additional 2 years in macromolecular chemistry. The students' costs for the extra years are covered by private industry but Zerbi determines the curriculum and the research topics.

Another aspect of the Italian educational system that disturbs Zerbi very much is that the students advance automatically through the curriculum; nobody fails and so there is no selection process. The result has been something of a decline in the quality of the graduates, and the selection process has now moved

into the workplace. Zerbi remarked however, that there has been something of a backlash to the situation in that the young university instructors who were themselves victims of an easy ride, are very demanding on their students, knowing that the weeding out process is much kinder in the university than it is in industry.

Zerbi's research field is the vibrational spectroscopy of polymers which he began as a student under Natta and continued as Natta's co-worker. His early work was funded by the US Department of Defense and although this support has long since ended, Zerbi is very grateful for this funding since it was instrumental in getting him started. While he was with Natta, his contribution was a kind of "service on demand." Zerbi and others using techniques that could be used to characterize new polymers were allowed to conduct independent research programs so long as they were available to Natta when needed.

Zerbi has always been interested in the structured defects in crystalline polymers which can be detected and characterized by infrared (ir) vibrational spectroscopy, Raman spectroscopy, and neutron scattering. Rarely, if ever, does a solid polymer have a perfect structure. Usually, such polymers contain defects in stereoregularity, discontinuities in the head-to-tail linking, conformational irregularities, and crystal defects. One of the more difficult problems that Zerbi has attacked is the phase transition in polytetrafluoroethylene (PTFE). His accomplishments in this work were highly significant, and part of his results are used commercially in the quality control of PTFE processing. In addition to PTFE, Zerbi has studied polyethylene (PE), polyvinyl chloride (PVC), and most recently, the nylons. His approach is to develop a theoretical spectrum, determine how this spectrum would be perturbed by specific defects, and then compare the results with experimental spectra. Although the mathematical computations are formidable, they can be done. Zerbi's biggest problem is obtaining polymer specimens with specific defects (commercial polymers have so many different types of defects that the experimental spectra are exceedingly complex). He would like very much to team up with a polymer synthesis group which could prepare materials in which one or two specific types of defects dominate.

Prof. L. Porri is also at the IMC. He worked with Natta at Montedison, then went to the University of Pisa in 1967. In 1973 he came to the IMC and in 1978 he succeeded Zerbi as the director, a position he still holds. Porri's work is on the mechanisms of the stereospecific polymerizations that occur on Ziegler catalysts. Such reactions were at the heart of Natta's immense contributions and Porri's research is an extension of this research. Despite their use in industry and the very extensive research work that has been done, the mechanisms of polymerization on Ziegler catalysts is poorly understood.

Porri is concerned with a number of aspects of Ziegler catalysis: the reaction sequence that inserts a monomer into a chain in a specific configuration, improvement in existing catalysts and development of new ones, and metathesis catalysts. In his work on stereospecific monomer insertion, Porri is studying reactions to isolate the sequence in the formation of polyolefins from cis- and trans-conjugated diolefins. The thrust of his work on catalyst development is to find aluminum (Al) based catalysts to replace the expensive platinum and palladium catalysts. Organometallic catalysts containing both Al and cobalt (Co) have been developed and Porri is trying to determine why both metals are needed and also why trace amounts of water are critical to the catalytic reaction. In some cases, Al/Co-based catalysts are not sufficiently active. Although polybutene can be obtained with 98% cis configuration, polymerization of isoprene gives only 94% of the cis form which is not good enough for commercial production. Porri's work on metathesis essentially involves fundamental studies of the reaction mechanisms using monometallic catalysts where the metal is usually tungsten.

The city of Padua, with its ancient university, is about an hour's drive from incredible Venice. Galileo taught at the university and his lecture chair is still on display. Because he was a rather short man, his students modified his chair so that he could be seen over the lecture table. My host at the University of Padua was Prof. M. Mammi, who heads the CNR Biopolymer Research Center (BRC). The center is internationally known for its work with peptides and proteins. The staff at the BRC interacts rather extensively with the biochemical community in the US through collaborative research and sabbatical visits. The BRC is engaged in five major research areas: protein synthesis and structure-property relationships, enzymes from thermophilic bacteria, studies of model polypeptides, X-ray investigation of natural and synthetic biopolymers, and biomedical applications of enzymes. In the work on proteins they are studying the competition between

peptides and proteins that inhibits neurotransmission. The work is being done in cooperation with a pharmaceutical firm in Padua (the company does the animal testing). The group at BRC is also investigating the antifreezing glyco-proteins which are found in fish in the Arctic and Antarctic. These proteins can depress the freezing point of water by 10 to 15°C but their actions do not constitute a simple colligative depression. The researchers are trying to determine the mechanism of the action of the glyco-proteins and are presently synthesizing model compounds. Another aspect of the protein studies involves electron transfer reactions of metalloproteins with metallic complexes. This work is being done in collaboration with Prof. H.B. Gray (California Inst. of Technology). One of the recent findings is that the oxidation and reduction steps apparently take place at different sites on the protein molecule.

The work on enzymes from thermophilic bacteria is being done in collaboration with the Institute of Pharmaceutical Chemistry (CNR, Univ. of Padua). The bacteria are found in hot springs in south Padua. These enzymes have high thermal stability but are otherwise similar in structure to enzymes found in normal temperature bacteria. Structural analysis of these enzymes is being done in collaboration with Dr. I.M. Chaiken (National Inst. of Health, Bethesda, MD).

The model polypeptide program involves the synthesis and characterization of such compounds as poly-D-phenylglycine and poly-D-cyclohexylglycine. Both these compounds have random coil configurations but the Padua group has shown that the coil configurations transform to planar zig-zag configurations in H-bonding solvents. The scientists find that another polypeptide, poly(γ-ethyl N-methyl)-L-glutamate forms a stable helical coil in aqueous solution with a hydrophobic core. They use X-ray diffraction, solid-state and liquid ir, and circular dichroism to determine structure.

Mammi indicated that one of their most difficult problem areas is the X-ray investigation of natural and synthetic biopolymer crystals. They are trying to study arginase microperosides, hemocystine, and various protamines. The difficulty is in getting large enough crystals for X-ray analysis. To address this problem, a small laboratory is being set up by Visiting Prof. H.L. Monaco (Harvard Univ., Cambridge, MA) that will be devoted to developing improved techniques for growing protein crystals.

In recent years the CNR has established "target directed" programs in which research is aimed at specific end uses. The target may be a specific industry requirement but the research may be quite fundamental. At BRC there is a target-directed program on the biomedical applications of enzymes, more specifically, the use of enzymes as detoxifying agents in artificial kidneys. In this work detoxifying enzymes are isolated and then immobilized on the inside surfaces of hollow tubes made of polymers similar to those used in artificial kidneys. The current work is on urease for urea removal. Another target-directed program just underway at the BRC concerns the synthesis of industrial chemicals from cellulose. The CNR established this program under the strong urging of Snia Viscosa (Milan).

The Institute of Physical Chemistry at the University of Rome has a strong effort in polymers—mostly biopolymers. The staff involved in this research includes four chemists, two physicists, and two biologists. The position of the director of the institute is rotated among the senior staff members. The current director is Prof. F. Conti.

Conti is basically a spectroscopist; he is principally interested in nuclear magnetic resonance (nmr), and in spectroscopy of natural and synthetic polymers in the solid state and in solution. He has used nmr to investigate the structure of polybutadiene and ABS (acrylonitrile butadiene styrene). Recently he has been applying nmr to food chemistry to determine the liquid/solid ratio in butter and the water content in casein.

The bulk of Conti's work is on biopolymers. Using nmr and polarized light spectrofluorimetry to study the structure of phospholipids and their interactions with proteins, he finds theoretical problems in interpreting the data. His work with phospholipids (PL) also includes their use as drug carriers. He has found that the PLs give better cell penetration; 70% compared to the usual 40%. Conti has a patent on the use of PLs as drug carriers and is continuing to work on the technique with the pharmaceutical department at the university.

Another aspect of Conti's work is on the chemistry and structure of cell walls. Using electron paramagnetic resonance (epr) he is studying the iron ion and peroxide in red cell walls and correlating cell growth with the epr response. In related work he is doing research on membranes and their interaction with enzymes, specifically ATPase. Using spectrophotometric techniques, he is examining the specificity of enzymes for phospholipids and also drug/phospholipid/enzyme interactions.

Prof. A.M. Liquori, who recently finished his term as director of the institute in Rome, has done considerable work on the thermodynamics of protein structures. He, like others in the biopolymer community, has been reexamining the question of the double-helix configuration proposed for DNA. Liquori is doing both theoretical and experimental work on this problem. He is also involved in transport processes across biological membranes, especially transport against concentration gradients. The energy for this counterflow comes from chemical reactions. For example, an ionic imbalance allows amino acids to migrate against concentration gradients. Liquori is using irreversible thermodynamics to model membrane transport and as an outgrowth of this theoretical effort he has developed a generalized Onsanger theory which he expects to publish shortly. Liquori talked at length about the thermodynamic stability of the tertiary (folding) structure of proteins. He noted that in the evolution from simple animals, i.e., mold, to man, that folding is an invariant. In fact, the change in amino acid sequence is always the retention of tertiary structure. Consequently, it is not possible to discuss evolution in terms of changes in protein—man simply has more of them. Liquori believes that evolutionary changes are associated with changes in gene structure.

Prof. E. Giglio is an electron diffractionist and he has used this tool with other techniques to study the structure and conformation of biomaterials and synthetic polymers. His work on the sodium salt of desoxycholic acid is rather interesting. This salt forms micelles in aqueous solution and with changes in ionic strength or pH the micelle size increases until a gel forms. Giglio says that the micelles appear to elongate during the gel formation. The gel can be pulled into fibers but after drying the fibers develop into small crystals. Curiously, the micelles, fibers, and crystals give the same diffraction pattern and presumably the same structure. Giglio is developing a distribution function in an attempt to model the diffraction pattern. He believes that the structure is helical, that the sodium ions are in the core of the helix, and that they are strongly hydrated by water (there is no change in density when the fibers dry to form crystals). However, Giglio finds that the micelles solubilize small organic molecules such as toluene or styrene which is not consistent with an ionic core to the micelle.

At the University of Naples, I spoke with Prof. P. Corradini in the Institute of Chemistry. The institute has a staff of over 50 professionals, about half of whom are working on polymers. Corradini had also been associated with Natta in work on isotactic polypropylene. At Naples, Corradini's work is on the structure of crystalline and amorphous polymers, gels, and liquid crystals.

In his studies of crystalline polymers, Corradini is interested in the structural transformations that result from annealing (in going from the molten to the solid state) and are induced by elastic strain. In the latter connection, he is studying the stress-induced crystallinity of 1-4 cis polybutadiene; a property which makes this elastomer of less commercial interest than the isoprene-based rubber. Part of his polymer structure work is done for industry in a cooperative CNR-industry (Italian) project to determine the defect structure of commercial-grade polymers. Presently, he is working on polyethylene terephthalate using X-ray diffraction and circular dichroism.

Corradini and his co-workers are quite interested in the so-called, "Keller gels". These gels were discovered by Prof. A. Keller (Univ. of Bristol, UK), who found that rapidly-quenched solutions of polymers formed clear gels rather than turbid suspensions of small crystals. The gels do not seem to have the crystal structure that relates in any clear-cut fashion to the normal crystal structure of the polymer in the solid state. Corradini is not in full agreement with Keller's interpretation of this phenomenon. Corradini thinks that the gel structure is a network of very highly extended chains.

The work at Naples on polymer liquid crystal systems differs from most of the research in this area around the world. Corradini is investigating the ordering of polymers with alternating stiff and flexible chain segments; specifically a stilbene-adipate copolymer. Most of the work on polymer liquid crystals has been on fully rigid chain polymers. Corradini has found some curious results with his alternating stiff-flexible copolymers. He has evidence for some ordering of the flexible segments. Also, the liquid crystal structure of the rigid segments is shorter and narrower than predicted by theory. In addition, as the polymer is heated from the crystalline state through the liquid crystal region to the liquid state, the liquid crystal has a lower viscosity than the fully-molten liquid. This observation would seem to suggest that in the liquid crystal condition,

the mobility of the flexible segment is very high and uninhibited by the rigid segment domains, but that when fully liquid, the rigid segments hinder viscous flow.

Corradini explained that the principal reason for the liquid crystal work is the search he and his colleagues are pursuing for energy-storage materials: materials with high enthalpy per unit mass transitions. Most work in this area is on solid-liquid transitions, but Corradini is looking for a solid-state transition. This work is being done in cooperation with the Engineering Department of the University of Naples and the Montedison Company.

My brief look at polymer research in Italy left me impressed with the amount and quality of the work. There may be social problems, and certainly the equipment and facilities are less than one would expect in other western European countries or in the US. Nonetheless, it would be a mistake to say that Natta's legacy has been lost. (Willard D. Bascom)

MEDICAL PHYSICS

A VISIT TO THE INSTITUTE FOR RADIATION HYGIENE OF THE FEDERAL HEALTH OFFICE IN MUNICH

At a medical physics and bioengineering conference held in Sofia, Bulgaria at the end of October 1980, I heard a paper delivered by Dr. Hans Detlev Roedler. It was notable for me for several reasons: it was the best paper I heard at the conference; it was on a subject of considerable interest to me (I have worked in the same field), the biokinetics and dosimetry of radiopharmaceuticals administered to humans; and it was given in English. Roedler is from the Federal Republic of Germany (FRG), which means West Germany, and he works for the Bundesgesundheitsamt (Federal Health Office), also referred to as the BGA.

Our mutual interest in similar research areas led to an invitation for me to visit the BGA (and Roedler himself) at its location near Munich. Munich is a city with a long history. Numerous archeological studies show that the area around Munich was settled in prehistoric times. The region was conquered by the Romans in 15 BC, but it was not until 777 AD that the name Munichen (the home of the monks) first appeared in a document. Even after this, it apparently did not achieve its official status as a city for a few more centuries, since Munich celebrated the 800th anniversary of its founding in 1958.

The BGA is about 100 years old, but it moved into its new quarters in Neuherberg, a suburb just east of Munich, only one year ago. The choice of the Munich area evidently was based on several factors: there were several excellent University teaching hsopitals there; it was the center of major technological and electronic companies like Siemens; and good land was available just on the outskirts, which belonged to the Federal Government, and which would permit expansion.

The BGA employs about 1,500 persons of whom some 400 are scientists. It is composed of 7 separate institutes: (1) Robert Koch Institute (virology, bacteriology, immunology, biochemistry, cystology); (2) Institute for Water, Soil, and Air Health Studies; (3) Max von Pettenkoper Institute (Toxicology); (4) Institute for Social Medicine and Epidemiology; (5) Institute for Radiation Hygiene; (6) Institute for Veterinary Medicine; (7) Institute for Pharmacological Chemistry, Experimental and Clinical Pharmacology, and Drugs.

Roedler is on the staff of the Institute for Radiation Hygiene, which employs about 100 persons including a scientific staff of 40 to 50. For the past 10 years the director of the institute has been Prof. Dr. F.-E. Stieve (a radiologist who recently reached the mandatory retirement age of 65). Prof. Dr. A. Kaul, director of a nuclear medicine department in Berlin, will be his replacement as the new institute director. The basic mission of the institute is to study the impact of radiation (both ionizing and nonionizing) on human health. To accomplish this rather broad aim the institute is organized into 3 departments. The first is concerned with basic science, and includes studies of genetic and somatic effects, radiochemistry, chemical radiopharmacy, dosimetry and radiation physics, and studies in nonionizing radiation (electromagnetic radiation, electric fields, ultra-violet radiation, lasers, ultrasound). The second department includes the medical radiation health areas (nuclear medicine, diagnostic radiology, radiotherapy, biokinetics of radiopharmaceuticals, medical aspects of radiation effects). The third department is concerned with environmental studies (natural and man-made radioactivity in air, soil and water, radio-ecology).

Roedler works in the second or medical department. He is responsible for the areas of nuclear medicine, studies of the biokinetics of radiopharmaceuticals, use of radioactive materials for humans in research, and radiation accidents.

Although he is a relatively young man (under 40), he is unusually well qualified for his post. It is interesting to note however, that he did not move forward in a straight line from his earliest schooling to his present position. As a child he was encouraged to play the violin. He developed this talent by obtaining a fine musical education. He played very well and graduated from a musical academy with highest distinction. He has performed professionally with the Berlin Symphony Orchestra, and has been on tour with other well-known orchestras for several years. At some point in this career, however, he had some doubts about whether he really wished to be a professional musician for the remainder of his life. He had been reading about the exploits and accomplishments of some famous scientists, he found this rather inspiring, and he decided to study physics! He did not stop until he earned the PhD degree in physics with distinction. In his scientific studies he became intrigued with radiation and its uses as a powerful tool in nuclear medicine. It was a small step to decide that his studies should continue, this time for the MD degree, with some specialization in the direction of nuclear medicine.

The Institute of Radiation Hygiene was formerly part of the Institute for Water, Soil, and Air Health Studies. The latter had been formed originally to study the fallout from atomic bombs. However as medical aspects increased in importance, including the tremendous growth of nuclear medicine, the Institute for Radiation Hygiene was split off as an independent entity about 10 years ago. The institute reports to and provides advice to two separate government departments: the Ministry of Health and the Ministry of the Interior. The reporting to the Ministry of Health is straightforward enough. The Ministry of the Interior is in the act because of its responsibility for large areas of safety for the public, including all safety aspects of nuclear power plants, with radiation protection a major concern. It follows logically that this ministry should have responsibility for other aspects of radiation protection, including that related to medical uses of radiation.

One consequence of the Ministry of Interior's responsibility is that it funds a good portion of Roedler's research programs. Among the most important of these are the previously mentioned studies of the kinetics of radiopharmaceuticals that are routinely used for patient studies. The use of radiopharmaceuticals for diagnosis is governed by the idea of maximum benefit and minimum risk. The benefit comes from the diagnostic information obtained, which is essential for the patient's health. The risk is associated with the absorbed radiation dose to the patient: to his (or her) whole body, to selected organs, and to the gonads (genetic effect). Thus a knowledge of the internal absorbed dose as a consequence of the administration of a radiopharmaceutical is an essential in obtaining a measure of the risk to the patient. Another purpose of being able to determine the absorbed radiation dose is to have the ability to assess alternate means of obtaining similar diagnostic information. The problem in determining absorbed radiation dose in an organ is that usually it cannot be measured directly. Instead, the dose must be calculated for relatively simplified models whose input data is often uncertain. The following simplified presentation should serve to synthesize the statements above.

The basic equation for a calculation of the internal dose for an organ may be written as: $D(r_k) = A_o \sum_h t_h \cdot S(r_k \leftarrow r_h)$.

$D(r_k)$ is the absorbed dose (rads) in a target region r_k
A_o is the administered activity (μci)
t_h is the residence time (h) of the activity in the source region.
$S(r_k \leftarrow r_h)$ is the mean absorbed dose in a target region r_k per μci·h in a source region r_h (rad/μci·h).

Of the paramters on the right hand side of the equation the quantity A_o is known by direct measurement or is known from a supplier. The quantity can be calculated from known properties of the radiations emitted by the radiopharmaceutical used, and from the geometry of the source region relative to the target region. It is the parameter t_h which is often not well known. Biokinetics is the quantitave description of the uptake, distribution and retention of a radiopharmaceutical in the tissues of animals or man. The purpose of biokinetics is to determine the residence times t_h for individual source regions r_h. In addition to the distribution and retention of the radiopharmaceutical, the residence time t_h includes physical decay. The residence times t_h are usually determined by total body counting, and by measuring bodily excretions. However, after administration of a radiopharmaceutical there is often a rapidly changing distribution within the body that introduces uncertainty in total body counting information. In such instances residence times may be computed from excretion measurements combined with

total body counting data. Roedler has designed a program to obtain needed residence time data which will be obtained at 5 university hospital nuclear medicine departments, using gamma cameras. Three of these hospitals are in Berlin, and that part of the program is under the supervision of Prof. Kaul. Two of the hospitals are in Munich: The Ludwig Maximilian University Hospital and the Technical University Hospital. The program started in the fall of 1980 and will continue for a total period of 3 years. This is an ambitious program, but it has been well planned and should produce very valuable data that will extend our knowledge of the internal absorbed radiation dose for organs for the most commonly used radiopharmaceuticals in nuclear medicine. Actually, Roedler has a headstart on this project in terms of background work already published. In 1974 he and his colleagues published an extensive review of biokinetic data. This work was based on Roedler's thesis required for the MD degree in Germany. The review is a massive 600-page document with the title "Radiopharmaceuticals, Biokinetic Data and Results of Recalculations of Internal Dose"; A. Kaul, K. Oeff, H.D. Roedler, T. Vogelsang, Informationsdienst für Nuklearmedezin, Berlin, 1974. (Reprints available from Roedler). Kaul and Oeff are respectively the heads of the nuclear medicine division and the radiology department of which the former is a part, in which Roedler did his work. T. Vogelsang is the present Mrs. Roedler, and was the nuclear medicine technologist who assisted Roedler in this research work.

Another area of research for Roedler is the investigation of an imaging technique known as single photon emission computed tomography. The idea is similar to that of the well-known computed tomography used with an external X-ray beam to image a "slice" of tissue. In the instance of the single photon emission technique one depends on the "internal" source of radioactivity due to the biological transport of an administered radiopharmaceutical to an organ of interest. The emitted radiation from the selected slice of tissue in the form of photons leads to an image formation. It is Roedler's objective to make an assessment of the clinical usefulness of this method in obtaining diagnostic information. Since patients are not seen at the BGA, a cooperative arrangement has been worked out with Prof. Dr. U. Bühl, Director of the Nuclear Medicine Clinic at the Ludwig Maximilian University Teaching Hospital. The equipment for this study had been purchased and installed in the hospital by a French concern, CGR, shortly before my visit in January 1981.

A third research project is in the planning stage only, with a literature review just being started. It is the question of the radiation dose delivered to organs of the unborn fetus from radionuclides administered to the pregnant mother, or even from emissions of a nuclear power plant. The Ministry of the Interior is supporting this work to the extent of funding 1 physicist and ½ technical assistant to perform the literature survey. The difficulty with this project is the paucity of information for humans although there are some animal data. One study indicates that if the pregnant mother has ingested or has had administered ^{131}I, then the concentration of ^{131}I as iodide in the fetal thyroid is about double that of the mother. There is also the suggestion that the biological elimination time for the fetus may be one half or even less than that for the mother. If correct, this would be a factor of amelioration, but the question remains, "How much lower "? Another nuclide of concern is Sr, a component of A-bomb testing which appears as fallout. In this instance there is likely to be considerable literature available.

In terms of support budget it is interesting to note that the Ministry of Health pays the salaries of all the permanent staff, whereas the staff support budget for investigative work comes from the Ministry of the Interior. There is routine work to be done, and the Ministry of Health pays for that. The routines include answering questions from the public (via the Ministry) about radiation, advising the Ministry on matters involving radiation exposure, and making scientific judgments on the use of radionuclides in medical research. This last is done by reviewing applications from physicians, usually hospital connected, who propose new procedures involving the use of radiopharmaceuticals with humans, initially with volunteers. The difficulty here is the rather restrictive legislation on the statute books which mandates that such new procedures not expose the volunteers to more than 10% of the permitted dose for radiation workers (i.e., 0.5 rem/yr with 1.5 rem/yr to certain organs, compared to 5.0 rem/yr for radiation workers). If all the radiopharmaceuticals currently in accepted use in Germany had been subjected to this restriction at the time they had been introduced, then some 2/3 of them could not have been tested under the present legislation. Another restrictive aspect of current legislation is the edict that volunteers under 50 years of age not be used ordinarily in testing programs. Roedler believes these

restrictions should be eased while appropriate safeguards are retained against possible abuse. He stated that the legislation had been introduced because of the abominable and reprehensible practices in the Nazi era of experimenting with humans.

PLEASE REMEMBER THE READERSHIP SURVEY QUESTIONNAIRE

Roedler and his young colleagues whom I met are the new representatives of scientific medical research in West Germany, and I found them to be a very able and serious group which augurs well for their country. (Moses A. Greenfield)

OCEAN SCIENCES

THE ISRAEL OCEANOGRAPHIC AND LIMNOLOGICAL RESEARCH LTD.

The Israel Administration for Oceanography and Limnology was set up in 1967. Between 1967 and 1972 its name was changed several times. In 1972 it merged with the Sea Fisheries Research Station in Haifa and adopted its present name, Israel Oceanographic and Limnological Research Ltd. (ILOR). The headquarters and main laboratory were established on the Mediterranean coast at Shikmona in the southern outskirts of Haifa. A satellite laboratory, Kinneret Limnological Laboratory, was established jointly with Mekorith (the Israel Water Company Ltd.) at Tabba, near Tiberias, on the shores of the Sea of Galilee (Lake Kinneret). A second satellite laboratory, the Mariculture and Brackish Water Aquaculture Center, was established in Elat. The article is concerned with the main laboratory near Haifa. Articles on the activities of the two branch laboratories will appear in subsequent issues of *ESN*.

The bright, new building housing the center in Haifa was formally opened on its completion in August 1976. It is on a point surrounded on three sides by the Mediterranean Sea with the upper stories extending out over the water. It has about 2,400 m^2 (26,000 ft^2) of floor space.

The director general, Rear Admiral Yohay Ben-Nun, is a national hero. At the age of 17 he joined a commando unit of the Hagana and fought in the War for Independence, during which he was wounded twice. When he was 20, he organized and commanded an underwater demolition team to help try to break the British embargo of refugee ships. At 23 he commanded merchant ships running the blockade. For outstanding bravery in action he was awarded Israel's highest military award (equivalent to the US Congressional Medal of Honor). Only a dozen awards of the medal have been made (5 posthumously). After studying for 4 years at MIT and holding various command positions, he became, at the age of 35, commander in chief of the Israeli Navy. Ben-Nun resigned that post in 1966 to become head of the Israel Oceanographic and Limnological Research Ltd.

The laboratory's ship, the R/V *SHIKMONA*, is 25 m long and has a displacement of 120 tons. It has a crew of 8 and berths for 9 scientists. It is a converted stern trawler with an exciting history. For a decade it was operated by a kibbutz along the hostile shores of the Red Sea. It was purchased by the center in 1967. In view of the impending closure of the Suez Canal (it was closed in June 1967), the vessel was stripped of everything identifying it as belonging to Israel. It was given a set of false Greek registry documents, an all-Greek crew was flown to it, and it made a dash through the Suez Canal to the Mediterranean Sea. Ben-Nun believes that it was the last ship to pass through prior to the closure.

The last IOLR triannual report listed over 100 staff members in the 3 laboratories. The objectives of ILOR, as originally set forth, are: (1) to undertake research in the fields of oceanography and limnology aimed at the exploration, exploitation, and conservation of stocks and natural resources of the seas and on Israel's shores; (2) to preserve Lake Kinneret, the only sizable freshwater reservoir in the country; (3) to prevent pollution in coastal waters and on beaches; (4) to protect the coastline against erosion and deterioration due to building activities in the coastal area; (5) to channel and coordinate the research efforts of various governmental agencies in the above listed fields; and (6) to advance the research activities carried out by ILOR through coordination with the appropriate departments in Israeli universities and other institutions of higher learning. Another of its aims is to develop and improve the technology of commercial mariculture and aquaculture for the use of the nation's farmers.

Dr. Artur Hecht heads up the 8-man team in the Department of Physical Oceanography at IOLR. Between November 1975 and March 1977 they carried out 7 hydrographic cruises in the eastern Mediterranean Sea between the Israeli coast and 33° E longitude. The same 20 stations were occupied

on all cruises. On each station an Aanderaa current was used to measure and record water temperature, conductivity (salinity) and currents at 20 depths. The current meter was kept at each depth for 10 minutes to measure the current relative to the ship. Decca Hi-Fix monitored the ship's drift.

The number of stations has now been expanded to 28 to extend the area covered to as far west as Crete. Four cruises have been made at 3-month intervals. The aim is to study the deep-sea circulation in the eastern Mediterranean. The team uses a Neil Brown CTD and a Nisken Rossette with reversing thermometers to obtain calibration data at each station. The entire system is computerized and prints out the data in real time. This program is sponsored by the Israeli Navy.

The physical oceanographers also do pre-engineering studies of the marine environment for proposed coastal construction projects. They measure currents in shallow water near shore in a unique way. Current meters are placed on frames on the sea bottom or on a cable running from the bottom to a submerged float. Divers are used to install, service, and retrieve the current meters. Very precise navigation is required to relocate the current meters. The meter sites are fixed and relocated by sightings through three theodolites spaced along the shore.

Supertankers frequently pass through the tricky Strait of Tiran at the southern end of the Gulf of Elat. Hecht's group has made very precise bathymetric charts of the strait and a thorough current meter survey of the area. These data are used as aids to navigation by the supertankers and other ships bound for the ports of Elat in Israel and Aqaba in Jordan. The oceanographers have also made long series of current measurements close to shore along the coast south of Haifa to determine the pattern of coastal currents that carry and distribute pollutants from land and move sediments along the shore. The near-shore current pattern is used to help establish regulations controlling the disposal of pollutants into the sea at the shoreline. They also wanted to know how far out from shore the currents were strong enough to move sand on the bottom and found that with strong winds, sand was moved at locations well past the surf zone.

From the hydrographic data Hecht's group has learned that gyres appear in the geostrophic current patterns away from shore. They do not have enough current meter data in the eastern Mediterranean Sea to directly verify the presence of gyres. The results from current meters lowered from research ships were inconclusive.

Dr. Z. Ben-Avraham is head of the Geology and Geophysics Department at IOLR. In his absence I talked to Dr. V. Goldsmith. Goldsmith, an expert on beach processes, holds a faculty position at the University of South Carolina and worked at the Virginia Institute of Marine Science (VIMS) on the Chesapeake Bay until he moved to Haifa 6 months ago. In the past he had frequently been a visiting scientist at IOLR. His work is sponsored by the International Sea Grant Program and the Geography Program of ONR.

Goldsmith developed a wave climate model for the whole coast of Israel using all available wave data (60,000 measurements). He constructed wave refraction diagrams using several different wave periods. After collation is completed he hopes to publish an atlas of wave height, direction of movement, and wave period statistics for the whole coastline. These data will then be used to develop a model of sediment transport. I could believe him when he stated that he was going to "do the hell out of the statistics." He is a prolific worker. He showed me a large number of well-organized charts and diagrams based on wave statistics.

Goldsmith is now completing a monumental study of long shore bars and other shoreline features on the Israeli coast. He has related the characteristics and types of bars and other features directly to wave data. Most features that are found elsewhere in the world are also found in Israel. These include crescentic and multiple bars and cusps. He has found that the spacing of beach features is related to wave characteristics.

In cooperation with many other individuals, Ben-Avraham has helped obtain a number of seismic profiles over the continental margin west of Israel. They have concluded that the continental margins of Israel, the Sinai, and an offshore sea mount are all tectonically controlled. One of the main reasons for the seismic profiles is to search for possible oil-bearing structures (An article on offshore oil prospecting will appear in a later issue of *ESN*, and will concern the activities of the Marine Geology Division of the Israel Geological Survey).

A second multi-institutional cooperative program consisted of geophysical studies of the Dead Sea Rift from Lake Kinneret on the north through the Dead Sea and on to the south through the Gulf of Elat.

Cooperative geophysical studies in other parts of the world that Ben-Avraham has taken part in include: the structure of the Chagos-Laccadic Ridge in the Indian Ocean (with Woods Hole Oceanographic

Institution); the tectonics of southeast Asia; the morphology of continental collision belts; the tectonics of the eastern Mediterranean; and the Pacific evolution in regard to the lost Pacifica continent (with Stanford University). Mr. Y. Mart, another member of the group, has participated in studies of the structure of the northern margin of the Bay of Biscay using a submersible (with the Centre Océanologique de Bretagne); and of the structure of the Hellenic trenches (with the Univ. of Paris).

During the last two decades many coastal construction projects such as anchorages, groins, and breakwaters have been built along the eastern coast of Israel for industrial and recreational purposes. These projects have interfered with the long shore sand transport, causing sand accretion in some places and erosion in others. In order to define these processes quantitatively, a team consisting of Dr. A. Golik, Mr. P. Rubinovich, and Mr. A. Aharonov have conducted recurrent bathymetric and shoreline location surveys in the vicinity of a number of coastal projects.

I was told that the Geology and Geophysics Department was growing, with special emphasis on coastal processes, and that half a dozen researchers would be working in this field by the end of 1981.

Dr. U. Pollinger, head of the Marine Biology Department, informed me that while all of the research in her department had to be pertinent to economic problems, the research was really a judicious mixture of applied research and basic research in support of applied research projects.

Pollinger's group is doing fascinating work on an alga called Dunaliella. This tiny plant with a diameter of 20 μ lacks cell walls. Its outside cover is a very fine membrane. Because of the permeability of the membrane, the alga must be isotonic with the surrounding seawater or it will become either desiccated or flooded with water. It must keep the ionic concentration in its body fluids equal to that in the surrounding sea water. It has adapted to this situation. It manufactures a large amount of glycerol (glycerin) in solution with its body fluids. It also contains β carotine. When subjected to hypersaline conditions such as those that occur in saltwater marshes or in closed or nearly closed tropical lagoons, some species can adjust their glycerol content upward. One red species with a high β carotine content (*Dunneliella bardawil*) has been isolated from the very saline Bardawil Lagoon on the north coast of Sinai and is being cultured successfully at IOLR. It not only has a higher β carotine content than other species that have been studied, but also has up to 50% of its dry body weight made up of glycerol.

Glycerol is a primary ingredient of some explosives. According to the Encyclopedia Britannica it has thousands of other uses including being an ingredient in resins and gums for paints and other protective coatings, processed tobacco, toothpaste, cosmetics, and pharmaceuticals. It is now made from expensive petroleum. Because Arab countries control many of the petroleum sources, it may be hard to ship sufficient petroleum into Israel to meet all its needs. The idea behind present research on Dunniella at IOLR is to develop the technology for mariculture of the algae on a commercial basis.

REMEMBER THE READERSHIP SURVEY QUESTIONNAIRE, PLEASE

The Biology Department staff has progressed from culturing the algae in small containers to 300 liter clear-plastic tanks to large tanks on the roof of the IOLR laboratory. Staff members now feel that they have developed a knowledge of the optimal conditions required to mass culture the algae. Economic studies show that glycerol derived from algae may be produced for about half the cost of glycerol derived from petroleum. The technology has been turned over to a commercial firm, Koor Foods, in Haifa, which plans to operate a 20,000 m^2 pilot plant in Elat.

The byproduct β carotine has a ready market as a food coloring. After glycerol and β carotine have been extracted, the residue remaining has a 70% protein content which will used to feed livestock and also to feed fish in mariculture ponds (*ESN* 34-12:560 [1980] "Mariculture Research in Israel"). Only in the aura of zionist zeal pervading in Israel could people dream of producing valuable and scarce commercial products by the ton using an alga with individual plants that are so tiny they can hardly be seen with the naked eye.

Pollinger's team is now studying the body chemistry of other marine species that grow in high concentrations of salt in a search for potentially valuable compounds other than glycerol, β carotine, and protein that may be concentrated.

Another project in the biology department is concerned with optimizing food production of rotifers, copepods, and other small marine animals that are used for food in mariculture hatcheries. This food is needed only during the hatching

season. The department is also working on methods of preserving and storing the algae that the zooplankton feed on and believes freeze-drying to be the best method. The staff has developed methods to obtain resting eggs from some species of zooplankton and is now carrying out research to find out how to store the eggs in viable condition and then hatch them on command when they are needed.

The "living fossil" horseshoe crab (Limulus) is found in only a few places in the world and has a complicated system for reproduction similar to that of large sea turtles that come ashore to spawn in the sand. Its blood is valued as a base for tests for bacteria endotoxins and it has other medical research uses. Limulus is expensive to catch and ship. Over 30 years ago I kept limulus specimens in live boxes in Chesapeake Bay for the use of researchers at the Johns Hopkins University Medical School, where its large uncomplicated optic nerve was used in nerve function research (although it has no functioning eyes). Because of the expense of obtaining live limulus specimens, Pollinger's group set out to culture them and was successful in this effort. I was shown immature, young limuli about the size of a silver dollar.

The last subject that Pollinger discussed was the ongoing program on the ecology and taxonomy of dinoflagellates causing superbloom red tides in Lake Kinneret and in aquaculture ponds. It is hoped that these blooms may eventually be controlled.

I talked with Boris S. Krumgalz, a physical chemist, about the chemistry program at IOLR. (Krumgalz emigrated from Russia 4 years ago. He said that when he applied for his exit-visa he immediately lost his job and was without work for 3 years until he was granted an exit-visa to come to Israel.) Much of the work in the chemistry group concerns the chemistry of the Dead Sea. One of the largest sources of foreign exchange in Israel is the sale of chemicals extracted from Dead Sea water. This nets the country about $300,000,000 a year. Protection of this income has a high priority.

Krumgalz is studying the behavior of ions in hypersaline waters. He is particularly interested in what effect introduction of Mediterranean water for generating electrical power will have on the Dead Sea water which is almost an order of magnitude more saline than the Mediterranean water. Whether some salts will flocculate is one question to be answered. If flocculation occurs, solar ponds for generating electricity will not be as efficient as hoped. One problem is the accurate determination of the concentrations of various salts in Dead Sea water and other hypersaline waters. Analytical chemical analysis of Dead Sea water by usual methods is accurate to no less than ±2% in the best cases. Krumgalz is working on new methods to yield higher precision. He has first solved the problem for calcium and now is able to obtain an accuracy of ±0.2-0.3%.

Studies are being carried out in conjunction with the United Nations Environmental Program (UNEP) on the amount of trace metals and pesticides in fish and molluscs and on hydrocarbons dissolved in sea water. They have discovered one species of fish that concentrates mercury to dangerously high levels and have had it taken off the market. The fate of sewage sludge in sea water is also being studied under simulated conditions in the laboratory.

Dr. Amos Lanir discussed the hypobaric physiology program at IOLR with me. The laboratory has the largest human-rated pressure chamber in Israel, three smaller animal chambers, and a high-pressure cell for use on tissue. The installation of the main research chamber, which had been built for the US Navy and outfitted at the Duke University Medical Center, led to the establishment of a center for hypobaric physiology and medical research. A team made up of IOLR researchers, the research staff of the Naval Underwater Medical Institute, and part-time research scientists from the nearby School of Medicine of the Technion and the Israel Institute of Technology was assembled.

The big chamber, which will hold 5 to 6 patients, is the center for caisson-disease treatment for the whole country. Patients are flown in by helicopter. To date 20 patients from the hospital have used the tank when they needed oxygen under pressure as part of their treatment. Patients are also treated who have suffered from gas gangrene, air embolism either in the brain or lung, CO poisoning from inhalation of smoke, and some specific infections.

About a third of the research is on O_2 toxicity, how to prevent it, understanding its mechanisms, the pathology of the lung, and damage to the brain and ear. One program is concerned with the effects of certain medicines on oxygen toxicity. The scientists are trying to find out why the effects take place. Work is also underway to evaluate decompression tables.

IOLR was a fascinating place to visit. When the scheduled time was up I could hardly pull myself away from some of the interviews—especially the

biology review. As I mentioned in my writeup of the satellite mariculture center in Elat (*ESN* 34-12:560 [1980]), the approach taken to most problems is not what one can or cannot do, but how long it will take and what it will cost.

The director general is a soft-spoken man with an encyclopedic knowledge of the happenings in his laboratories. He ran over each program without notes, using Latin names and scientific notations. He graciously insisted on having a staff member drive us to the Sea of Galilee to see the Kinneret Limnological Laboratory and incidently go through Nazareth and the neighboring town where Jesus turned the wine into water. The laboratory is in the center of the piece of shore on the Sea of Galilee where many of Jesus' activities mentioned in the Bible took place. (Wayne V. Burt)

THE LAKE KINNERET LIMNOLOGICAL LABORATORY, ISRAEL

It was a thrill to stand on the veranda of the small chapel on the Mount of the Beatitudes where Jesus is said to have given the sermon on the Mount and look out over the nearby Sea of Galilee which is called Lake Kinneret. To the left one can see a small, green oasis on the shore marking the ruins of Capernaum where the Bible tells us Jesus chose his first disciples: Peter, Andrew, James, and John. Directly ahead is the tiny St. Peter's Bay on the shore of which Jesus performed the miracle of the loaves and the fishes. A little to the right is a small, inconspicuous knoll that from a financial standpoint is one of the most valuable pieces of real estate in Israel. Buried in an artificial cavern inside the knoll are three massive pumps that can pump as much as 65,000 m^3/hr out of Lake Kinneret (209 m below sea level) and up and over the surrounding hills from where it flows by gravity to furnish a large share of the fresh water used on the coastal plain for agriculture, industry, and human consumption. Lake Kinneret is Israel's only large reservoir and its waters play a major role in making Israel's agriculture a success. The hill is surrounded by barbed wire and protected by armed soldiers.

Beside the pumping station are a small, artificial harbor and a long, low building that houses the Lake Kinneret Limnological Laboratory (LKLL). Farther down the shore toward the city of Tiberias is the spot where Jesus is said to have encountered Mary Magdalene.

The laboratory is a branch of the Oceanographic and Limnological Research Ltd. in Haifa (*ESN* 35-2:77 [1981]), but its funding comes from the Israeli Water Commission.

Lake Kinneret plays an important part in the water economy of Israel. Although the average volume of water coming into the lake is of the order of 650 million m^3, 250 m^3/year are lost to evaporation, and only 300 to 400 m^3/year are pumped into the National Water Carrier canal system and distributed. Essentially all of the available water in the lake is used. The lake furnishes from one fifth to one fourth of the available water in Israel. Aside from the contribution of water the lake's most important role is a regulatory one. Winter floodwaters from the Jordan River are stored in the lake and are available for irrigation in the summer when other water supplies are low. Water from rainy years can be stored in the lake and used during dry years. A year's supply of water can be stored in the lake by raising the water level only a little over 2 m.

Prior to June 10, 1964, when the National Water Carrier was inaugurated, the coastal aquifer had been overutilized with a consequent lowering of the ground water level and intrusion of salt water from the Mediterranean Sea to the point that the water in the aquifer could no longer be used for irrigation. In the winter of 1964-65 forty million m^3 of water, mainly from Lake Kinneret, were pumped into the aquifer to push the salt water interface back. This worked so well that the next year the pumping was increased to one hundred million m^3. Now, during rainy years when the lake is full to capacity, any excess water is pumped into the aquifer for additional storage.

The use of Lake Kinneret water was not without its growing pains. Prior to 1961 the waters of the lake were almost twice as salty as they should have been to be used for irrigation. This saltiness was in part due to the 1.5 m/year evaporation rate. The main source of salt, however, was from numerous saltwater thermal springs around the edges of the lake and on the bottom of the lake. Luckily, most of the springs were on the western bank. These were diverted into a canal and were led around the lake to an outfall below the dam that is used to keep water in the lake.

The Jordan River (upstream from Lake Kinneret) and its tributaries pass through the Hula Plain in the northern part of the Jordan Valley. Part of this flat area had been a lake and swamp long enough to accumulate a deep layer of highly organic nutrient-rich sediments. Most of the

swamp and lake were drained and reclaimed for agriculture and aquaculture between 1951 and 1959. Fishponds were constructed and fertilized with nitrogen and phosphorus and more such nutrients were leached out of the rich peaty soil. Some water from these ponds drains into the Jordan River which then carries the nutrients downstream into Lake Kinneret. However, the ratio of P to N was much smaller than that used by most algae. This favored the growth of a single species of dinoflagellate (*Peridinium cintunium*) which is able to build four to six times more organic matter than other algae for a given amount of phosphorus. Thus, if other conditions are optimal, tremendous blooms occur in the spring after the winter overturn of water in the lake has taken place. At times over 90% of the plankton biomoss is made up of this single species. This species is not grazed on by zooplankton because of its large size and hard shell. It is, however, an important source of food for the endemic fish Tilapia (*Sarotherdon galileaum*). The fish is commonly called the St. Peter's fish because it naturally spawns in and near St. Peter's Bay.

The *Peridinium* blooms gave the water of the lake a bad taste and threatened the eutrophication of the whole lake.

In certain years, because of special physicochemical modifications of the environment, *Peridinium* is repressed in late winter and spring and replaced by nannoplankton algae. These algae are grazed on by zooplankton and the zooplankton are eaten by sardines; this changes the main food chain of the lake to a marked degree.

Many individual research workers have studied various bits and pieces of the trophic relationships in Lake Kinneret; some of the studies extended back to the middle of the 18th century, but no one really had the full picture. With things going from bad to worse in the 1960s, it was decided to call for outside expertise in the search for better methods to manage Lake Kinneret. For assistance they chose one of the world's most eminent limnologists, Prof. W. Rhode from Uppsala University in Sweden. Rhodes' special interests are algal ecology and eutrophication. (Rhode is very impressive. Some years ago I had the good fortune of traveling with him and a group of limnologists visiting lakes in Austria. He not only could answer almost any question about lakes, but explained things very fluently in four languages.) Rhode emphasized the advantages of concentrating research efforts in one lakeside laboratory. This advice was accepted in 1967 and the new Kinneret Limnological Laboratory was opened in 1968 at Tabgha just north of Tiberias.

Although many studies had been made on the lake, the dynamic processes of the ecosystem were not understood. For example, the causes of the algal blooms were not understood and the reasons for the dramatic changes in blooms from year to year were a mystery. Since blooms are the integration of meteorological, physical, chemical, and biological factors, a 10-year interdisciplinary research program was established. The main disciplines to be studied were meteorology, hydrodynamics, water chemistry, phycology, zoology, microbiology, biochemistry, and sedimentology.

The most dramatic changes in water quality of the lake have been made by decreasing the nitrogen inflow from the Hula Lake region. The region represents only 1% of the watershed but was providing up to 50% of the nitrogen to Lake Kinneret. A number of steps were taken that decreased the nitrogen supply. These included: reducing the flow of fresh water through the fish-rearing ponds; recycling human sewage water to irrigation; minimizing the water flow through the area by use of improved canals, dams, and gates; adjusting the water level to minimize oxidation and nitrification during summer and maximize water storage capacity during the rainy winter; and changing the irrigation system to a sprinkling system to induce denitrification.

In the meantime the team studying processes within the lake was able to quantify and model the carbon flow patterns in great detail. They now understand the "food web strategies" during the frequent "*Peridinium* bloom years" and the less frequent "nannoplankton bloom years." They are beginning to understand the downstream effects of changes in any step in the food chain and are beginning to plan how, when, and where they can nudge the environment in the lake to begin to control undesirable events. For example, an increase in the Tilapia population that feeds on the *Peridinium* would cut down the extent of the late winter and spring blooms. This could be done by controlling the catch, protecting the fish in the spawning areas, or artificially introducing more fish into the lake.

To celebrate the first decade of research at the Kinneret Limnological Laboratory a 500-page volume on the lake was published in 1978 (*Lake Kinneret*, Editor C. Serruya, Monographiae, Vol. 32, Dr. W. Junk Publisher, The Hague).

My host, Dr. M. Gophen, director of the laboratory, explained that during the eight months when the lake is stratified, the portion below the thermocline becomes anoxic. Whenever a high wind blows over the lake from the west the lighter oxygenated surface layer water is driven to the eastern side of the lake and on rare occasions the anoxic water upwells to the surface on the western side.

The laboratory was set up 12 years ago with the sole purpose of determining how to manage the lake and watershed to maintain the faunistic variety in the lake and at the same time optimize the water quality. Its success to date is yet another example of the zeal with which applied research (and supporting basic research) is approached in Israel. The laboratory functions as physician, lawyer, and policeman for the precious water of the lake. (Wayne V. Burt)

THE MARINE BIOLOGY GROUP AT THE UNIVERSITY OF TEL AVIV

The University of Tel Aviv, with 18,000 students, is the largest institution of higher education in Israel. Its precursor was an institute established in 1933 that was associated with a zoo in the southern part of the city. The institute's objective was to enhance the study of natural history among public school teachers. The university which developed from these humble beginnings is now housed on a bright, new, ultramodern campus in the northern outskirts of the city. Some of the architecture is rather startling. For example, the building which holds the zoology department has its windows on the sunny south and west sides shaded by barn-door-sized, fixed, concrete slabs. Many of the buildings have plaques, on the walls around their entrances, that list the names of overseas donors who helped fund the construction of each building.

The Department of Zoology is large, with 24 senior staff members and 40 teaching assistants. Its main function is teaching. In order to obtain funds from the Israeli Government for research, staff members must work on directly-applied research projects. Everyone I talked to was dedicated with zionist zeal to contribute to the welfare of I Israel. However, the teaching loads of 6-8 hours per week are light compared to those at universities in Europe which may range up to 28 contact hours a week.

REMEMBER THE READERSHIP SURVEY QUESTIONNAIRE, PLEASE

For the most part, undergraduate students in Israel are considerably more mature than those in other countries, because upon graduating from high school at the age of 18, Israeli men usually spend 3 years on active duty with the armed forces. Thus the average age of freshmen men is 21. Young women serve for 2 years in the armed forces. It was quite a surprise to me to see pink-cheeked, slight young ladies in uniform lugging around rifles and lethal-looking submachine guns.

Graduate students who fulfill all the requirements for the PhD degree are at least 29 to 30 years old when they finish. Then, if they aspire to teach in a university, they usually must complete several years of postgraduate research abroad.

The Zoology Department is unique in that it goes beyond using the usual laboratory animals for experiments and operates a large zoo nearby that is in the last stages of construction. I was shown several dozen species, both domesticated and wild, of large and small native desert animals that are used for experimental purposes. One of the large physiology laboratories is located in the center of the zoo compound.

My host, Prof. Z. Yaron, is a comparative endocrinologist. Much of his past research was concerned with the comparative endocrinology systems of commercially important freshwater fish and the glands in fish that secrete cortisone. More recently, Yaron has been working on osmoregulation of fish that are cultured in fishponds. Many hundreds of acres of fishponds are devoted to the culture of freshwater fish that are a major source of protein for the nation. The principal cultured species is the Saint Peter's fish, Tipalia (*Sarotherodon aureus*). This is a fish that spawns in St. Peter's Bay next to Capernaum in the Sea of Galilee and is credited with being the fish that Jesus used in the miracle of the loaves and the fishes. Because of the scarcity of fresh water, these normally freshwater fish, to be produced economically, must be reared in brackish water, a mixture of fresh water with up to 40% sea water. One problem in these brackish water ponds is the result of organic halogen pesticides such as DDT that were heavily used in Israel up to 5 years ago. The pesticides and their

isomers are very persistant. Their presence in fishponds inhibits the osmoregulatory systems in the fish. Understanding the osmoregulatory problems is of economic importance because it helps to determine the optimum maximum salinity that can be used in the ponds. Fish culture is carried out scientifically by well-educated fish farmers who endeavor to optimize all growing conditions and still operate as economically as possible.

As in mariculture (*ESN* 34-12:560 [1980]), it is also desirable to lengthen the spawning period of freshwater species of fish used in aquaculture in order to keep hatcheries busy and produce fish of marketable size on as nearly a year-round basis as possible. Some of the most recent research by Yaron and his co-workers has been to manipulate temperature and photoperiod to determine the effects of the manipulation on ovarian recrudescence in freshwater fish. They also investigated chemical methods of stimulating spawning out of season.

Dr. Y. Loya and his 5 PhD and 4 MSc student candidates are interested in all aspects of coral reef ecology and the effects of oil pollution on corals and associated symbiotic communities. Loya has been studying the coral reefs near Elat for almost 20 years. His group uses the Gulf of Elat as their natural laboratory. They make the 5-hour drive once each month and spend several days at the Steinitz Marine Biology Laboratory. In this way they can study the structure of the coral communities year-round. The corals form the framework for one of the most diverse ecosystems known in the marine environment. The complex of many species is interesting to study and is in some ways comparable to the tropical rain forest on land.

Systematic line transepts are made across the reefs at fixed locations. The diversity of the species of coral increases with depth down to at least 30 m. Loya has examined some coral reefs in the Caribbean and found the same diversity with depth. The major study underway is on the biology of corals, population dynamics, reproduction, and rate of colonization.

In 1970 an extremely low tide and low air temperature exposed some of the coral reefs for about 6 hours on 5 consecutive days. This killed all the coral that had been exposed. Oil spills near the city of Elat kept the coral from recolonizing the area near the supertanker terminals there. However, at a distance of only 5 km from the terminals, the rate of recolonization was extremely rapid.

As late as 1975 a major review of corals concluded by stating, "to date there appears to be no conclusive evidence that oil floating above reef corals damages them." Loya found the contrary. He and others have found that evidence is accumulating which indicates various detrimental effects of oil pollution (especially chronic oil spills) on coral reproduction, growth rate, colonization capacities, feeding, and behavioral response. The extent of damage varies with varying physical, chemical, and biological factors, and this tends to make each incident a unique ecological problem.

Loya's most recent new research program involves looking for biologically active material from the sea. Research funding for his coral research has become very scarce. The Swiss pharmaceutical company Hoffmann La Roche is partially funding the research. The Red Sea area is unique in the large assemblage of different species of soft corals and sponges that are present. These species are the subject of Loya's search for new chemicals.

Prof. L. Fishelson began to do research on corals in 1950, prior to Loya's research program. He was the first marine biologist in the department. For the past two decades his main efforts have been devoted to the biology, ecology, and behavior of pond-reared fish. Some of the problems in culturing tipalia are: (1) the males grow about twice as fast as the females and hence males are more desirable, and (2) the fish are very precocious. In mixed sex cultures they breed at an early age so that the ponds become crowded and growth is stunted. Early in the game the fish farmers stocked ponds with predator fish to eat the tipalia young.

Fishelson has been able to hybridize some species of tipalia and has come up with a very successful hybrid in which 90 to 99 percent of the young are males. The crop reaches commercial size much quicker. He has also worked on coral reef fishes and on the reproductive behavior and diversity of benthic (bottom-dwelling) communities within coral reefs. He has a wide range of interests including how and why some species of gastropods, for example, *Anthias squammipmis*, change sex. Other topics in which he is interested include the effects of oil pollution on marine life and the question of why some fish are quite tolerant to oil pollution.

The last member of the marine biology group is Dr. H. Levinson. His most recent contribution was made in cooperation with a student and involved raising a shrimp from the larval stage to commercial size. The student, Dr. Tzachi Samocha, is now raising another species of shrimp in the aquaculture laboratory in Elat (*ESN* 34-12:560 [1980]). Much of Levinson's time

is taken up by studying the benthic community in the Mediterranean Sea out to the 100 m contour.

The laboratories occupied by the Marine Biology Group in the Department of Zoology of Tel Aviv University are large and well equipped, and the individuals I interviewed were hard-working, dedicated, productive scientists. (Wayne V. Burt)

OPERATIONS RESEARCH

SYSTEM APPROACH FOR DEVELOPMENT

The 3rd Conference on System Approach for Development, sponsored by the International Federation of Automatic Control (IFAC), was held in Rabat, Morocco, 24-27 November 1980. It was cosponsored by the International Federation of Information Processing Societies and the International Federation of Operations Research Societies. The conference had been planned for Tehran, but when it became obvious about 2 years earlier that this was not a reasonable venue, it was decided to hold it in Rabat. The organizer and guiding spirit of the conference was Prof. Mohamed Najim (Mohamed V Univ., Rabat) who was described in *ESN* 35-1:34. He was supported by a large national organizing committee and an even larger international program committee with representatives from more than a dozen countries. The conference was attended by more than 200 people of whom a bit more than half were from outside Morocco; many of these were from other developing countries, especially Arab nations. Of the more than 200 abstracts originally submitted, 73 were accepted and were on the final program (not all of these were presented because, as is usual these days in international meetings, there was a fairly large number of no-shows). In addition there were 7 invited papers, and a large number of people were invited to speak at so-called round tables.

An excellent 650-page bound volume of preprints, printed by Pergamon Press, was handed out to every participant at registration. Naturally numerous authors failed to get their papers in on time for this preprint volume, but some of those were available in the form of Xerox copies. The organization of the conference was characterized by a somewhat casual attitude toward the timing of events.

In the words of Rudyard Kipling, "there are 67 ways of composing tribal lays, and every single one of them is right." I am always intrigued by the number of different ways of arranging a conference. At this one, each morning and afternoon started with an invited paper that was called a tutorial and which was scheduled to take 40 minutes. None of them were what I would describe as a "tutorial," although most were indeed somewhat broader than the usual research report that one finds in a technical session at a conference. In most cases the tutorial was followed by simultaneous sessions of invited technical papers, usually moderately well classified into particular topics. There were also 10 "round tables," usually scheduled for about an hour at the end of a morning or an afternoon session.

Thus, each day was well filled with technical material. With the exception of the tutorials, there were usually two, and occasionally three, simultaneous events, giving the participants what I considered to be a reasonable choice. (I am always appalled by modern meetings where there are 20 or more simultaneous technical sessions.) And, of course, there were the usual social events, including a "typical Moroccan dinner" (at an extra fee of 40 Swiss francs; it is of some interest to note that the charge for such things is generally no longer stated in US dollars). At the dinner, we were seated on cushions around a low table, in the center of which was placed a large plate of common food. However, unlike the real Moroccan thing, we were given knives and forks. We were also entertained by dancing (which, in my opinion, will never sell) by Berbers, members of the basic Moroccan tribe living mainly in the mountainous regions in the south of the country.

REMEMBER THE READERSHIP SURVEY QUESTIONNAIRE, PLEASE

Morocco is a country where virtually everyone is bilingual. Generally the two languages are French and Arabic, although in the rural regions of the south it may be Berber and Arabic, and in the coastal strip along the north it may be Spanish and Arabic. The highly educated usually also speak English. The language of this conference was English, and it was advertised that all papers would be presented in English with simultaneous translation into French. In fact, some of the papers were given in French with simultaneous translation into English. The translation was excellent, better than at most international conferences. Interestingly, the title of the conference in French, *La Cybernétique et le Développement*, was rather different

from the English title. (Both the French and English titles were prominently displayed in 20-foot banners at several places in Rabat!) The conference was opened by Mr. Laraki, the Minister of Education in Morocco, who spoke in Arabic. Since the conference organizers were not prepared for this, there was no simultaneous translation, although there was a summary in French afterwards which was translated into English.

The second speaker was Tibor Vámos (Director, Computer and Automation Inst., Hungarian Academy of Sciences—see *ESN* 34-10:490 [1980]), who is first vice president of IFAC and will be its next president for 3 years. Vámos is a man of small stature, but of imposing presence and great competence. He spoke cogently and substantively of the contributions which automatic control might make to the development and transfer of technology and knowledge, but he also spoke of the debt which Europe owes to the Moslem culture, a debt which is being repaid with technology; and he asserted that he was optimistic that system engineering could help mankind. The third speaker was Jacques R. Fayette (OECD) who spoke in French, nominally on behalf of the International Federation of Operations Research Societies, although he was quite pessimistic about the possibility that operations research could contribute to development. Najim then ended the opening session, presenting some of the statistics cited in the first paragraph of this article. At the closing session a few days later only Najim and Vámos spoke, and their comments were more of a protocol than of a substantive nature.

An interesting tutorial on "Power system control and automation" was delivered by M. Ribbens-Pavella (S.A. Intercom, Brussels) although the written version indicated that the senior author was J.P. Waha of the University of Liège. She started by asserting that the blackout in New York City in 1965 was "the best damn thing that ever happened" to the power-system industry, because it forced that industry to reexamine the systems and thereby gain an understanding of them. They are, she asserted, "the largest man-made interconnected systems" in the world. Because they are so large, a hierarchical concept is required in their operation, control, and automation, and some aspects of the control must be decentralized. She recommended that long-term functions such as economic dispatch of power and scheduling of new plants should be centralized, as should functions needing the overall system aspect, such as assessment of security. According to the speaker, dynamic emergency situations and restorative functions should be handled by decentralized control systems at lower hierarchical levels. The trend is to centralize, at least to the extent of having central real-time simulations and result analyses, except of course for emergencies.

Vámos gave an interesting tutorial on "Artificial intelligence, automatic control, and development." He reviewed the state of the art, asserting for example that voice recognition systems today have a limit of distinguishing about 100 words, which is about the capability they had several years earlier. According to Vámos, a system which claimed to be able to recognize about 1,000 words was not in fact practical. The most promising application of visual input to automatic devices is mass screening of X-rays and other photographic images. He also asserted that the most significant progress in artifical intelligence in recent years has been achieved in the development of what he called "expert systems," in which one attempted not to analyze formally complex problems such as the playing of chess, but instead to extract heuristics by examining the strategies used by experts. Hardware developments have of course been proliferating. Vámos then spoke of the work in his own institute on intelligent robots, for use primarily under conditions unsuitable for humans, such as high temperatures, radiation, and poisonous atmospheres. He pointed out the importance of the recognition by the robot of the task to be done, such recognition being more difficult than the implementation after that decision has been made. Recognition by the robot may be rendered very difficult by changes in illumination, shadows, changes in viewing angle, and the like. He discussed the creation of "picture grammars," a special kind of computer language to describe objects to facilitate this recognition. Vámos ended by first assuring his listeners that he disapproved strongly of those who expressed opinions about developing countries without a deep knowledge and understanding of those countries, and then suggested that high-level technology is unavoidable and that artificial intelligence and automatic control could be very useful in development.

More typical of the conference was a paper presented by M.A.R. Ghonaimy (Ain Shams University, Cairo [the printed version listed S.E. Aidarous as senior author]) on "Medical information systems." He asserted that such systems represent a breakthrough, outlined areas of application, discussed constraints and limitations, and summarized schemes for protection of information and the like. He ended with a "case study," which turned out to be

a listing of how clerical data concerning a patient and data concerning electrocardiograms and chest X-rays would be stored in a computer.

Three papers were presented by Americans. The author of the first was on the staff of the University of Petroleum and Minerals, Dhahran, Saudi Arabia, at the time his paper was submitted. (He subsequently returned to the US.) The other two US papers were among the very few at the conference that had no mathematics. The second, by S.L. Hacker (Assoc. Prof. of Sociology, Oregon State Univ.), discussed the human and social costs of technological change. Hacker presented a great deal of data on the effects of automation, showing in particular that in practice, regardless of the good intentions of the developers, automation results in losses of jobs primarily for women, while the compensating new jobs that are created are frequently primarily for men. She went on to assert that emphasis on mathematics and engineering education serves as a filter restricting women's access to the upper levels of the field, and recommended that calculus not be required as a prerequisite for engineering education.

The final US paper, by R.E. Burns and E.A. Kline of the History and English Departments respectively of the Univ. of Notre Dame, dealt with computer-assisted instruction (CAI). The authors pointed out the tremendous promise of CAI, especially with the dramatic improvements in microprocessors. They asserted that the reason there had not been more success with CAI in the past was the lack of adequate instructional materials, and claimed a breakthrough for a new type of instructional material which they had developed and which they called "tutorials." The basic idea of such a tutorial is to have the computer present a "lead" of about 100 words stating a rule or principle for subsequent application, or supplying special instructions or explanations. The lead is followed by a question and a set of multiple-choice answers, usually four. The student selects one of the answers, and the machine then indicates whether or not the answer is correct, and also gives a lengthy explanation why it is or is not correct. The authors asserted that this particular type of CAI had met with enormous enthusiasm and success on the part of both instructors and students.

G. Bel (Automatic Control Dept., Toulouse, France) and C. Maertens and J. Puech (Toulouse Research Center) presented a paper on modeling the water-soil-crop system. The idea was to calculate the water content of the soil at various depths from descriptions of the soil parameters and crop parameters together with data on the rainfall. This would allow better prediction of the irrigation requirements and therefore a more efficient use of irrigation water. They had approached this problem primarily by collecting data for many years on the actual humidity of soil at various depths, at various times, and with various crops. During the question period it became apparent that if such modeling were successful, it would be enormously important and valuable to the practice of irrigation; but there seemed little likelihood that the state of the models described by these authors was such that they were close to practical utilization.

H. Chou (Dept. of Automation, Shanghai Inst. of Technology, People's Republic of China) presented a paper entitled "Development of a new heat power system." Since we hear so few papers from the PRC, I made a special effort to attend this one, but I was unable to comprehend either the oral or the written version. Chou asserted that all existing heat engines were characterized by work feedback, whereas he is developing a kind of heat engine which is distinguished by heat feedback, and one which has higher thermal efficiency and higher power-to-weight ratio than existing engines. He cited references to some of his own papers in Chinese going back to 1977 on this same topic.

As can be seen, the papers in this conference were a mixed lot. Some, especially the more technical and specific papers in the fields of optimal-control and adaptive-control theory, were unquestionably first-rate contributions. Even some of the lesser papers represented comparatively significant accomplishments for members of the developing nations who presented them. The conference was doubtless of enormous benefit to many of the delegates from the developing nations, and many invaluable contacts were made there; but unlike some international conferences, it did not appear to be a forum in which many first-rate pieces of analytic research were reported. (Robert E. Machol)

PHYSICS

FOURTEENTH EUROPEAN CONFERENCE ON LASER INTERACTION WITH MATTER

The Fourteenth European Conference on Laser Interaction with Matter was held at Ecole Polytechnique in Palaiseau, France, on September 15-19, 1980. The scientific program was devoted to laser plasma interactions, transport problems, compression studies, numerical simulations, diagnostics, and target design. The working language of the conference was English.

Although the conference was listed as a European conference, in reality it was an international conference. It was attended by 152 persons from 13 countries of Europe and the rest of the world, representing most of the major scientific groups that are working in the general area of laser fusion. The conference was organized such that there was only one session held at a time, and as a result all participants could hear every talk. Since Ecole Polytechnique is located in Palaiseau, a suburb of Paris, the conference participants generally could not easily drift away during the meeting and, consequently, most sessions were well attended. Also, since the coffee breaks and lunches were held in the same building as the conference, it gave the attending scientists ample time to have informal conversation with each other. The organizing committee had done an excellent job in planning the program and coordinating the logistics for the meeting.

Approximately 88 papers were presented at the conference, and 15 of these were invited papers primarily presenting overviews of the work of the larger research groups. In this review I will point out highlights of the conference, without attempting to describe each paper presented.

The conference was opened with two invited papers, an overview by M. Decroisette of the program at Limeil Laboratory, and a similar paper of the work at Projektgruppe für Laserforschung (PLF), Max Planck Gesellschaft at Garching, Germany, by S. Witkowski. At Limeil they were using both glass and iodine lasers to study the compression of microballoons in the Exploding Pusher regime and more recently in the Ablative Implosion regime. Also physics experiments irradiating foil targets, both single and double, were being carried out, and X-ray shadowgraphy using an auxiliary X-ray light source and a X-ray streak camera was being done.

The PLF Garching group is continuing to do experiments with its iodine laser, ASTERIX III, 3500J/300 ps, and a Nd/YAG laser, 10GW/30 ps. Recently, these scientists have achieved up to 60% conversion efficiency in the 2nd harmonic, 6% in the 3rd harmonic, and 5% in the 4th harmonic. The main emphasis in their program has been the study of energy transport using calorimeters, and high-speed photography of shock waves propagating through transparent materials. Also, their group has a small theoretical effort. Some surprising results at irradiances of 10^{15} W/cm^2 were reported by R. Fedosejevs. He observed "lightning-like" discharges occurring ahead of the shock waves. He and his colleagues felt these were caused by fast electrons which are ejected into the target ahead of the shock wave.

David Forslund (Los Alamos National Laboratory) suggested that time and space-resolved measurements of the visible harmonic lines emitted when CO_2 laser beams of high-irradiance strike targets could be used as a diagnostic of profile steepening and of the velocity of the critical density.

In an overview of the laser fusion program at the University of Rochester, L.M. Goldman stated that experiments on the 24 beam laser would begin in the late fall of 1980 or early in 1981. Most of the measurements that he described were energy and spectral measurements of stimulated Brillouin scattering, backscatter and side-scatter experiments. He observed greatly enhanced scattering but reduced production of fast electrons when the main laser pulse is preceded by a prepulse. Also, he reported on X-ray spectroscopy of Argon-filled microballoons, which showed a compression of 100X liquid density (greater than the density of lead).

O. Willi and P.T. Rumsby reported on observations of filamentary structures extending into the corona region of the target irradiated with a Nd:glass laser at 10^{13} - 10^{14} W/cm^2. Studies with polarized light indicated that magnetic fields in the megagauss range were associated with these filaments.

The overview of the laser-fusion program headed by N.G. Basov at Lebedev Institute in Moscow was given by G.V. Sklizkov. They are having problems with their large Nd:glass laser which is still not operational, so most of their data was taken on a smaller 6-beam laser which has an output of 300J/beam. He described experiments to determine the beam divergence in their laser, theoretical studies of the magnetic field at the critical surface, and a calculation

of the X-ray flux which agreed well with the experiment. They are continuing to do pellet experiments in the presence of background gas, so that with Schlieren photography, shock waves from the laser target interactions can be followed. Using this technique they feel they can measure the absolute energy absorbed to an accuracy of 30%. In the near future they plan to irradiate pellets with an aspect ratio of 100:1 with 10^{14} W/cm^2. They expect the laser uniformity to be 1%.

The experiments being done at the Los Alamos National Laboratory were reviewed by D. Giovanelli. Most of the experimental data was taken on the Helios system which can produce up to 11KJ in 8 beams. (Their larger 40KJ machines, Antares, will not be ready until 1983.) They reported on transport studies done on laminated targets and observed K_α radiation. Also comparison experiments on Argon-filled pellets were described.

Studies at the Naval Research Laboratory of the laserablative acceleration of targets to high velocities were described in three papers by S.P. Obenschain, M.J. Herbst, and E.A. McLean. These experiments were done with a Nd:glass laser operating in a lower irradiance regime, 10^{14} W/cm^2, which has the advantage of good laser-target coupling and the absence of laser-plasma instabilities present at higher irradiances. A two-foil technique was used to measure target velocities ranging up to 150 km/sec. One problem of working in this irradiance regime with long-pulse lasers is that it will lead to large plasmas with long gentle density gradients. This often leads to filamentation and enhanced backscatter phenomena. Time-integrated images at $(3/2)\omega_o$ and $2\omega_o$ have shown fine scale spatial modulation transverse to the laser axis. To study the fuel preheat problem, time-resolved spectral intensity measurements on the back side of the laser irradiated foil targets could be used to get the rear-surface temperature versus time, provided it could be shown that the rear surface was radiating as a black body. These measurements indicated that the temperature generally remained only a few eV for times less than typical pellet implosion times.

N.G. Kolvalsky (Kurchatov Inst., USSR) described experiments accelerating thin foils by laser irradiation. The experiments were in the same energy range, i.e., 300J/3.5ns, as those of NRL. One and two-dimensional calculations agreed with their measurements of temperature and foil velocities and showed that in the irradiance regime of 10^{13} - 10^{14} W/cm^2, X-ray preheating effects were very important.

The extensive laser research program at Rutherford Laboratory was reviewed by M.H. Key. Their research plans include a 1200J 6-beam Nd:phosphate glass laser to be ready in 1981, and a 200-J KrF laser also to be ready in about 1 year. (This would give them the world's most powerful KrF laser.) A large variety of diagnostics were being used to investigate laser-matter interactions including X-ray backlighting to observe symmetry in pellet implosions, Faraday rotation and short-time photography to observe magnetic fields and filamentation effects, and X-ray spectroscopy to observe pellet compression. Also, a computation program showed that as the aspect ratio $r/\Delta r$ went from 10 to 100 the theory went from good agreement to disagreement with experimental results. J.D. Kilkenny (Rutherford Laboratory) reported that the ablation pressure at .53 μm was three times the pressure at 1.06 μm at an irradiance of 2×10^{15} W/cm^2, and that spherical mass ablation rates were similar to plane mass ablation rates.

In the rush to get to much lower wavelength laser systems, J.T. Hunt (Lawrence Livermore National Laboratory) reported the conversion of 1.06 μm to 0.53 μm with 80% conversion efficiency and to 0.266 μm with 30-50% conversion efficiency. This was done with good beam quality. KDP crystals up to 15 cm diameter are available today. Wolf Seka (Univ. of Rochester) pointed out that to get these high conversion efficiencies one needed very good (0.2°C) temperature control of the conversion crystals.

The laser-matter interaction program at the S. Kaliski Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland, was presented by S. Denus. They have a 4-beam, Nd:glass laser with an output of 100J, 3-ns FWHM, which was

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used to do implosion experiments on microballoons. An impressive array of diagnostics including ion collectors, X-ray pinhole cameras, X-ray microscopes, fast X-ray detectors, calorimeters and X-ray streak cameras as well as many different type targets that were used in these experiments.

The overview of the Lawrence Livermore National Laboratory program was given by John Emmett, the program director. The main emphasis of his talk regarded the move to shorten laser wavelengths. This was due to the fact that recent experiments have shown that at shorter wavelengths the absorption is better, the backscatter drops off, and the fraction of hot electrons falls off. He feels that the use of the KrF laser to get lower wavelength output is not likely, because the KrF laser is marginal. One problem with recent compression experiments is that there is an unexplained lack of reproducibility in the results, where compressions range from 30-100X liquid DT. He described the progress on the new NOVA facility, which will cost $195M if operated at 1.06 μm, and 8-15% more if operated at 0.53 μm. He closed his talk with the statement that we must prepare for success, and start working on many of the reactor design issues.

There was a growing interest evident in the use of high power lasers to produce very energetic shock waves, i.e., shock waves with pressures of 50-250 MB. P.C. Thompson (AWRE, Aldermaston) presented a review of such studies and pointed out that it would be of considerable value to use lower wavelength lasers, e.g., $3\omega_o$, to produce these high pressures.

On the last day of the conference J. Nuckolls (Lawrence Livermore National Laboratory) gave an invited paper on Ignition and Scientific Breakeven. He defined Scientific Breakeven (SBE) as fusion energy ≥ incident beam energy, and Ignition as fusion energy ≥ compression energy in DT fuel. He then proceeded to set up two scenarios: one in which one gets SBE or ignition at 10KJ laser energy, and the second in which one gets SBE on ignition at .1 - 1MJ laser energy. To achieve SBE at 10KJ one needs to pulse shape, velocities of 4×10^7 cm/sec, and target aspect ratios of 20:1; and to a achieve SBS at .1 - 1MJ one needs only a gaussian beam, velocities of 3.2×10^7 cm/sec, and < 10:1 target aspect ratios. From this line of reasoning Nuckolls concluded that it may be faster and cheaper to build a large driver, and he emphasized that it should be at a short wavelength. Also, he said that inertial confinement experiments using light and heavy ion beams looked very promising as well. He closed his talk by saying we need better diagnostics of laser pellet experiments, particularly, good density and temperature profiles are needed, and he reiterated that there is a need for experiments on non-classified targets as well as classified targets.

In summary, the conference stressed (1) the need for lasers with shorter wavelengths than 1 μm since short wavelengths look promising for the future; (2) better understanding of stimulated Brillouin and Raman scattering, and filamentation and the associated B-fields in the corona region; and (3) the growing interest in ablative compression experiments using lasers with longer durations and lower irradiances. (Edgar A. McLean, Code 4732, Naval Research Laboratory, Washington, DC)

SOME FINNISH FYSICS

HELSINKI

In the early fall of 1980 I visited several institutions in Finland. I noted while I was there that dusk came early each day; this was because of Finland's position in the time zone, not because of the season. In Helsinki (actually Espoo, a suburb) I went to the Helsinki University of Technology's Low Temperature Laboratory which is directed by Prof. O.V. Lounasmaa. Well known throughout the world, Lounasmaa is one of twelve research professors appointed by the Finnish Academy of Science. The laboratory has a complement of approximately 40 persons: 1 professor, 3 senior research scientists, 10 research associates, approximately 10 PhD students and the remainder undergraduate students. Up to the present, the laboratory has produced 20 PhDs, most of whom have found employment in Finland.

The low temperature properties of ^{3}He have been studied in this laboratory for several years. A recent publication on the specific heat between 1 and 10 mK is *Phys Rev Lett* 44, 1076 (1980). A more comprehensive study can be found in *Report* TKK-F-A415 (1980) of the Department of Technical Physics of the Low Temperature Laboratory. In this latter publication, heat capacity measurements from 0.8 to 10 mK and pressures from 0 to 32.5 bar in zero magnetic field have been reported. The authors have found that the critical transition temperature is T_c = 1.04 mK at zero pressure and T_c = 2.79 mK at the melting curve. The specific heat of the normal liquid is proportional to temperature except for low pressures and temperatures (below 3 mK) where an excess, thought

to be an intrinsic property of bulk liquid ^{3}He, has been observed. The effective mass of ^{3}He calculated from the heat capacity measurements which do not show an excess, differs approximately 40% from other values; this effect has been estimated to be larger than could be accounted for by differences in temperature scales. At the time of my visit one of the authors of the report, Mr. M.T. Manninen, was beginning a temperature scale determination in which he planned to measure the superconducting transition in W at 16 mK as a calibration point. Manninen pointed out that since the critical magnetic field for W was very small, the shielding had to be sufficiently effective to reduce the field below 1 μT (10 milligauss) in order to achieve an accurate result.

Another ^{3}He experiment was described to me by Dr. S.T. Islander who is building a rotating cryostat for NMR and ultrasonic investigations of vortices. Construction began in 1978 with an air bearing rotator and a cryostat support frame. Next, a ^{3}He - ^{4}He dilution refrigerator which could achieve 7 mK was installed, then a copper nuclear demagnetization stage which it was hoped would reach 0.5 mK was added. The rotating cryostat has a charcoal pump for the dilution refrigerator and an 8-inch main pumping line with a pressure compensator to remove forces on the cryostat. All other pumps will be disconnected when the cryostat rotates at rates up to 1 Rev/sec on the air bearings. Approximately 1,000 lb. of apparatus will rotate. The experiment will be controlled by a HP85 computer mounted externally. Information will be gathered by standard equipment in the rotating frame, then digitized and transmitted up the shaft on a beam of light. Electrical power will be supplied to the rotating frame through liquid metal feed throughs. At the time of my visit, Islander was preparing a test run of the entire refrigeration scheme. He hoped to be running an NMR experiment by early 1981 and he stated that this facility would be open for use by visiting scientists.

A recently constructed magnetically shielded room was shown to me by Dr. M.A. Penttinen, who is responsible for its instrumentation and operation. The room, which measured approximately 2.4 m on a side (almost an 8 ft. cube) utilized three methods of shielding: μ metal for shielding of static magnetic fields, sheet aluminum for eddy current shielding, and active shielding through field cancellation by current carrying coils. Each layer of the shielding was constructed by sandwiching two crossed sheets of μ metal between aluminum plates; the entire assembly is held together by rivets. The layers were joined by using μ metal and aluminum angles to form a cube with the complete structure formed by 3 cubical shells. The shielded room is situated within a specially constructed concrete room which rests on bed-rock and is reinforced with non magnetic stainless steel rods. Platforms, floors, benches and shelves in both rooms were constructed of wood joined by non magnetic fastenings. Penttinen who is developing a pickup for magnetoencephalography which utilizes 7 SQUIDS told me that suppressing interactions between the different SQUID pickups was a major problem. He hopes to begin operating soon with the first experiments to be of visual evoked response.

A magnetic filtration unit based upon high gradient field separation was shown to me by Dr. H.K. Collan. The device uses a 3 T superconducting solenoid encased in a special dewar which allows the bore of the magnet to be at ambient temperature. Packed into the 15.24 cm (6 in) bore are many disks of magnetic (430 stainless steel) expanded metal mesh. This inhomogeneous filling of the solenoid gives local high gradient magnetic fields which produce forces acting on small magnetic particles passing through the solenoid. The filter has very little flow resistance and can be used to filter either gases or liquids.

To date most of the particles filtered have been laboratory mixes of iron oxide particles in water (0.5 μm diameter). However, feasibility tests have been performed on the effluent from a hot steel rolling mill which contained approximately 300 mg/liter of solids (∿3.6 μm diameter). Collan has designed a magnetic filter which will satisfactorily separate this effluent at an average flow rate of 450 m^3/hr (1980 gpm).

Dr. Peter Berglund has constructed a superconducting drumtype homopolar motor in a research project financed 80% by a government grant and 20% by an industrial grant. Operating at 5.56 V and 10,000 A, the motor delivers 51 kW at 1200 rpm with a liquid helium boiloff rate of approximately 1.9 liter/hr. Current is passed between the stator and rotor using a GaIn alloy which is shielded from oxidation by He gas.

Berglund considers this project finished and ready to be adopted by industry. Meanwhile, he has begun a NMR imaging (tomography) project for which he has a government grant. In

this diagnostic procedure, a magnetic field of known gradient is impressed on the sample. Protons located at different positions see different fields and therefore have different resonance frequencies which can be correlated with their position because of the known gradient. The measured frequency density is proportional to the proton density and if measurements are performed in three orthogonal directions the proton density at a point can be obtained, and by repeating the measurements many times a 2D proton density map results. In medical work, the proton density map is referenced to water density. The September 1980 issue of *Radiology* contains 5 articles on work in this subject as carried out in the US.

TURKU

Several hours train ride to the northwest of Helsinki is Turku, the oldest city in Finland. Once a fur trading post, it became the headquarters of the Swedish invaders of 1154 in their Christianizing of Finland, and was briefly the capital when Finland was a Russian grand duchy. Belying its age, Turku appears relatively modern, a result of the great fire of 1827 in which much of the city was destroyed.

The University of Turku was established in 1920 and became a state university in 1974. In 1979, the enrollment was 9,500 of which 2,400 were in mathematics and science. Physically located on the campus, adjacent to the Physics and Chemistry Building is the Wihuri Physical Laboratory, whose deputy director, Dr. R. Laiho, told me that the laboratory had been jointly established in 1957 by the university, which provided the building, and the Jenny and Antti Wihuri Foundation, which provided a complete Collins helium liquifier.

Since the original donation, the foundation has continued to provide equipment. In 1962 the Finnish government began paying expenses and in 1977 the Wihuri Physical Laboratory became a research institute. The permanent staff include 3 research scientists, 5 technicians, and 1 secretary. Anyone with an acceptable research problem is welcomed so that the nonpermanent staff includes members of the Physics Department, the Chemistry Department, and Finnish industry. A special exchange agreement exists with the USSR and currently one scientist is visiting from the University of Leningrad. The laboratory has a number of research groups: NMR, Prof. M. Punkkinen; solid state spectroscopy and magneto-optics, Director R. Laiho; electron microscopy, Dr. P. Paalassalo; lattice dynamics and X-ray diffraction, Prof. V. Hovi; magnetic properties and phase transitions in solids, Prof. J. Pöhönen; magnetically polarized atomic hydrogen, Prof. M. Krusius; and cosmic rays and particle physics, Prof. J. Torsti. Most of the research in physics at the University of Turku is carried out in the Wihuri Laboratory.

Laiho told me about recently published Brillouin scattering measurements on tetragonal (TI) K_2CuF_4 in which a single mode Kr ion laser (λ = 530.86 nm) was incident on a 4 x 4 x 4 mm single crystal. The light scattered in the right-angle and back-direction geometries was analyzed using a triple-pass Fabry-Perot interferometer and the data was stored in a multichannel analyzer. From these results and using the X-ray density, a complete set (6) of elastic constants was determined. For comparison, ultrasonic velocity measurements were performed on the same crystal and, with the aid of some of my work, these measurements were used to obtain the 4 diagonal elastic constants. Where comparisons can be made, the agreement is reasonable between the two sets, although the ultrasonic constants are systematically lower. Both sets have relatively low precision, and the off diagonal constants are the least well known. The two sets of constants are close enough so that Laiho thinks it is difficult to tell whether the differences are real.

Laiho's group is also carrying out low-temperature Faraday rotation and absorption experiments on K_2CuF_4: a transparent 2 D ferromagnet below the Curie temperature (T_C = 6.25 K) in which the spins of the Cu ions are aligned in the base plane. Similar measurements on the orthorhombic ferrimagnet (T_C = 3.9 K) TbF_3 are also in progress.

Another experiment on K_2CuF_4 (*J. Phys C* 13 879 [1980]) was the recently published optical detection of a ferromagnetic resonance in which the crystal at a pumped helium temperature (1.5-1.8 K) was located at the end of a 35.4 GHz waveguide. Either He-Ne or Kr laser light was incident at the position of maximum microwave field; the resonance was detected by microwave absorption and by measuring the scattered light. Within the experimental accuracy, the intensities of the Stokes and anti-Stokes lines were found to be equal. The optical detection method had more, better resolved peaks in the intensity as a function of field plot and was thought to be able to detect new interesting features.

Resonant Brillouin scattering in tetragonal α-ZnP_2 was recently published by Laihos' group (*J. Phys. C*, 13 3977 [1980]). In these experiments the energy of the exciting light was close to the

band gap which was "tuned" through the 632.8 nm line of a He-Ne laser by changing the temperature from 300 to 480 K. Detecting the scattered light as above, Laiho and his coworkers found that the scattering decreased at the band edge (i.e., it decreased as the temperature increased) for interaction with both longitudinal and transverse phonons. These results were thought to occur as a result of an interference between the contributions from the resonant and nonresonant transitions, and as Laiho pointed out they meant that the large photoelastic coefficients of α-ZnP_2 were not particularly temperature sensitive below 380 K (which is considerably above room temperature). Such a material has the potential for interesting applications.

Dr. L. Kaihola discussed his recently published (*J. Phys. C* 13 2225 [1980]) measurements of the soft X-ray reflectivity of the L absorption edge in Co (~16 Å) and Ti (~27 Å). Bremsstrahlung radiation from a W target was reflected by a spherical mirror coated with the metal to be studied. The reflected radiation was analyzed with a blazed grating (600 lines/mm) and a proportional counter. Detailed results for Co showed a complex fine structure of the L edge which depended on the grazing angle of incidence. It was thought that this effect could be used to construct high reflectivity mirrors by combining multilayer films of adjacent elements.

Prof. M. Krusius, who has written many papers on ^{3}He, showed me his cryogenics laboratory. Krusius received his PhD from Helsinki in 1971 and remained afterward in a postdoctoral research position. He spent 1976-1978 at the University of California at San Diego (La Jolla) working in collaboration with Prof. J.C. Wheatley. In 1978, he returned to Finland as a professor at the University of Turku. Krusius is starting a cryogenic program and is constructing an elaborate cryostat for experiments on atomic hydrogen. At the time of my visit, the ^{3}He-^{4}He dilution refrigerator was undergoing tests and the dissociator for obtaining atomic hydrogen from H_2 gas was under construction. The first experiment planned will measure the thermal conductivity in gaseous atomic hydrogen which Krusius expects to be running in the spring of 1981.

The Finnish science I saw seemed to be well supported and to be carried out at a high level of competence. Scientific liaison in Finland presents few difficulties since virtually all technical people speak English. Travel and leisure time activities present a few odd problems, such as directing the taxi driver to the airport, and a cinema (which I decided against attending) showing a Japanese film with Finnish subtitles. (John R. Neighbours)

ULTRASONIC RESEARCH AT HULL

One fine fall day I visited the University of Hull located in the town of the same name, in northeast England. Dr. Stuart B. Palmer of the Department of Applied Physics and I had met at the Rare Earth Meeting where he discussed his measurements of elastic constants. Palmer told me about the university which is relatively young, founded 50 years ago, and the department which is even younger, founded in 1962. Currently, the department has research programs in solid state physics (3 staff, 3 research assistants, and 10 research students) and lasers (7 staff, 6 research assistants, and approximately 20 research students). The undergraduate students are physicists with a tendency toward experimental physics. They do considerable laboratory work in and with electronics, are given a very firm grounding in classical physics, and receive a physics degree.

Palmer told me about his research in ultrasonics which includes pure science and several applications. Using the pulsed ultrasonic method, he and his students have measured elastic constants and ultrasonic attenuation of many (8) rare earth metals and rare earth alloys. Both measurements are used to study the magnetic phase diagram of these materials. Recent work on a pure metal (*ESN* 34-7:355 [1980]) was the study of the third order elastic constants of Er in which the elastic constants were measured as a function of pressure and uniaxial stress.

Much of the alloy work is done in collaboration with French scientists at Grenoble. Two recent examples were the elastic constants of hexagonal CeNi, (*J. Phys. C: Solid St. Phys* 13 L743 [1980]) which were determined over the range 4-300 K and show no anomalies, and the elastic constants of cubic MnO in the same temperature range which were more interesting (*Solid State Commun* 34 663 [1980]). For MnO, velocity measurements were made for [110] ultrasonic wave propagation with a uniaxial stress applied along [111] in order to obtain a single domain crystal. Approaching the Neel temperature (T_N = 118 K) from above, the longitudinal constant $\frac{1}{2}(C_{11} + C_{12} + 2C_{44})$ and the fast shear constant C_{44} soften (decrease) drastically and become so attenuated as to be unmeasurable in the antiferromagnetic state; the slow shear constant $\frac{1}{2}(C_{11} - C_{12})$ has a cusp-like

behavior near T_N, a minimum at 121.8 K, a maximum at 120 K, and a rapid decrease which begins at T_N. An associated peak in the slow shear mode attenuation is observed at 121.8 K. The authors believe that this behavior is associated with a series of pre-transition effects in the paramagnetic state near T_N and that these effects preclude a study of critical exponents in the paramagnetic state.

Palmer also described several ultrasonic devices and techniques developed by his group: (1) High temperature techniques for long-term monitoring of hot materials have been developed for industrial sponsors. Operation up to 250°C is achieved with PZT transducers and operation up to 500°C is achieved with $LiNbO_3$ transducers. (2) A liquid level monitoring device has been developed which is fail safe. The ultrasonic plate wave propagates in a wave guide fashion in one of the sides of the container, and the liquid level is determined from the amount of loss of signal into the liquid. (3) A residual stress measurement device has been developed which uses shear waves polarized parallel to the stress. Variation of the ultrasonic velocity with stress is known from a previous calibration experiment and is used to obtain the residual stress. (4) A subsurface damage assessment device utilizing surface waves which propagate over a known, fixed distance has been developed. The waves generated by interdigitated transducers usable from 10 MHz to 2 GHz allow measurement of the subsurface damage which results from polishing.

Of particular interest to me as a person with a "bad back" was some medical ultrasonics carried out in collaboration with an orthopedic surgeon at Doncaster Hospital. It has been hypothesized that the size (and/or shape) of the spinal canal (vertebral foramen) through which the spinal cord passes may be correlated with a tendency towards back ailments. Measurements of the spinal canal in living humans are being carried out at the hospital as part of a survey partially supported by the Miners' Union and the Medical Research Council. The single transducer pulse-echo method utilizing 3-4 MHz ultrasound is used to measure the spinal canal opening. Originally, propagation was normal to the back giving one dimension of the opening. Later a second measurement was taken for propagation at approximately 15° from the normal (in between the bony projections of the vertebra) giving a second dimension and an indication of the shape of the spinal canal. This type of survey is expected to be quicker, cheaper, and is less invasive than a radiographic examination. If a correlation is found, this fact can be used to advise young people about the choice of a job.

Along with Dr. R.J. Dewhurst, Mr. A. Aindow and Dr. D.A. Hutchins, Palmer is working on a program funded by the Atomic Energy Research Establishment to generate efficiently ultrasound pulses by means of a Q switched laser. A 20 nsec pulse from a Nd:YAG laser incident normally on a surface will, at low power, generate a shear motion parallel to the surface as a result of thermal expansion. As the laser power is increased into the plasma creating regime a compressive wave with particle motion perpendicular to the surface is generated. The group has developed a capacitance type receiver for detecting the ultrasonic pulses and is working on an interferrometric one.

These research projects cover the spectrum from pure science to immediately useful application. After my brief visit with Palmer and his colleagues, I left Hull pleased to have seen a well balanced research program in applied physics. (John R. Neighbours)

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NEWS and NOTES

THE EUROPEAN MOLECULAR BIOLOGY LABORATORY

The need for collaborative ventures by scientists from different countries in Europe has been the subject of much discussion for a number of years. As far back as 1969, there was a proposal to establish a laboratory of molecular biology. There were strong opinions on both sides of the question. Some scientists maintained that such a laboratory would weaken national academic institutes striving to establish themselves in this rapidly developing field. Others were just as firmly convinced that this type of laboratory was essential if Europe was to maintain the initiative in fields where the great institutes of the United States had established a dominant position.

As it turned out, the European Molecular Biology Laboratory (EMBL) was finally established at Heidelberg, FRG, in 1974, and formally opened in 1978. The EMBL is supported by 10 of the 16 or 17 countries which form the European Molecular Biology Conference (EMBC). The 10 supporting countries are Austria, Denmark, France, FRG, Israel, Italy, The Netherlands, Sweden, Switzerland, and the UK. Although Israel quite obviously is not in Europe, it has a kind of honorary status there. (The remaining 6 or 7 countries belonging to the EMBC did not feel able to support the laboratory.)

The basic aim of EMBL is not to rival existing national institutes in Europe, but rather to do things which those institutes find difficult. The laboratory has 3 research divisions: (1) the Cell Biology Division, which includes recombinant DNA research, the so-called genetic engineering, at the highest levels of containment; (2) the Biological Structures Division, which employs physical techniques to study the biological structures of macromolecules, cell components, organelles, etc.; (3) the Instrumentation Division, which is devoted to the development of instrumentation for biology. This Instrumentation Division, whose work constitutes something like 50 percent of EMBL's activity, is an unusual feature in a biology laboratory.

EMBL also has two groups working away from Heidelberg. The first of these is at Deutsches Elektronen Synchrotron (DESY) in Hamburg. The synchrotron there produces X-rays that are perhaps a thousand times more powerful than can be obtained from any conventional X-ray tube. Since biological systems consist mostly of water, they give very weak X-ray patterns; therefore very powerful X-ray beams are required for biological studies. The group at DESY has designed and built all the equipment needed to use such X-rays for biological studies.

The second group away from Heidelberg is at the Institut Laue-Langevin in Grenoble, France, where there is a powerful neutron source. Facilities are available there for using these neutrons in biological research.

There are three categories of research scientists at EMBL: staff members, postdoctoral fellows, and visiting scientists who come to EMBL for short periods. Eventually, the number of scientists working at the laboratory at one time will be about 150. Of these, approximately 60-70 will be staff scientists, 40-50 will be postdoctoral fellows, and the rest will be visitors.

While EMBL is a rather young organization from which to expect numerous major achievements, there are several areas of research in which it considers itself to be particularly strong. First, it has several groups working on various aspects of biological membranes. These are important structures, because every living cell has a membrane separating it from the outside world, so an understanding of biological membranes is a very fundamental area of research and not an easy area, because membranes are very thin and delicate.

Another important area is investigation of the way in which virus particles get into cells, where they may cause diseases such as influenza. One of the problems is to determine how they invade the cell.

A third major investigative effort, which was mentioned earlier, involves recombinant DNA research. Basically, this is a tool for studying complicated genetic systems, particularly those of higher organisms--animal or even man--in which the genetic system is much more complicated than in bacteria. Work in this field includes the classical problem of differentiation.

Scientists pursuing these lines of research at EMBL are not quick to venture predictions about what future research efforts may encompass in a field as specialized as this. They limit their observations to the general proposition that molecular biology will more and more be seeking ways of studying more complex systems using devices like computers or techniques like recombinant DNA.

WIND ENERGY FOR ORKNEYS

A windmill which, when its blades are in a vertical position, will be almost as high as the clock tower of Big Ben in London, is planned to generate electricity in the Orkneys, an island group off the northeast coast of Scotland, in 1983 or 1984.

The $13.4 million project is the most ambitious renewable energy scheme yet to be given official support in the UK. All but $2.4 million of the cost of the "aerogenerator" will be met by the Department of Energy, with the rest being provided by the North of Scotland Hydroelectric Board.

If it is successful, the project could go a long way towards supplying electricity to the outlying Scottish islands, which at the moment are largely supplied by expensive diesel-driven generators.

Working at its full capacity of 3 megawatts, the aerogenerator will feed enough electicity into the island's grid to provide energy for 1,000 of the 8,000 domestic consumers.

A smaller machine with a 250 kilowatt capacity is planned to begin operation in October 1981 to provide experience for the running of the larger generator. This machine will be 1/12 the size of the commercial aerogenerator.

The big machine needs winds of between 16 and 60 mph to function. Those speeds are common in Orkney.

The hydro board has been experimenting with wind power since the 1950s.

NEW BODY PROPOSED TO CONTROL UK POLYTECHNICS

The UK Department of Education and Science has drawn up proposals which would remove polytechnics and colleges of higher education from the control of local authorities, which is the system in operation now. The proposals involve the establishment of a new, semi-independent, national body along the lines of the University Grants Committee. The new body would be responsible for allocating government funds to polytechnics.

The polytechnics, which have long been pressing for their removal from local authority control, will not see a second wish granted which would have given them even more autonomy: their degree courses will still have to be approved by the Council for National Academic Awards (CNAA), but they are likely to be given greater control over budgets, subject to any guidance or directions given by the new national body.

ONRL NEWS

Dr. A. Paul Schaap, currently a liaison scientist at ONR London, addressed the Royal Society of Great Britain on 31 January. Dr. Schaap, who is professor of organic chemistry at Wayne State University, Detroit, spoke on the topic, "Efficient Chemiluminescence from 1, 2-Dioxetanes: The Role of Electron-Transfer Processes."

OBITUARIES

Sir James Martin, who was managing director and chief designer of the Martin-Baker Co., Ltd., died on 5 January at the age of 87. Martin's name is preeminently associated with the Martin-Baker ejection seat, which he designed in 1944 and which revolutionized the concept of safety for military aircrews in the event of combat damage or accident. Used by air forces worldwide, Martin's ejection seat is credited to date with having saved the lives of more than 4,700 airmen throughout the world.

Dr. Conmar Robinson, a research chemist who devoted much of his efforts to the study of liquid crystals, died on 13 January at the age of 82. He was much concerned with the development of molecular models which illustrated the structure of polymers, including biologically important ones such as nucleic acids and fibrous proteins. His main work, however, was on liquid crystalline forms of solutions of the synthetic polypeptides.

REMEMBER THE READERSHIP SURVEY QUESTIONNAIRE, PLEASE

ONR COSPONSORED CONFERENCES

OHOLO Conference on "Biomimetic Chemistry and Transition-State Analogs: Approaches to Understanding Enzyme Catalysis," Zichron Yaacov, Israel, 22-25 March 1981.

International Conference on Creep Fracture of Engineering Materials and Structures, Swansea, UK, 24-27 March 1981.

Norwegian Electro-optics Meeting 1981, Vinstra, Norway, 29 March-1 April 1981.

Conference on Interfaces in Composite Materials, Liverpool, UK, 1-2 April 1981.

2nd International Low Temperature Biological Microscopy and Microanalysis Conference, Cambridge, UK, 6-9 April 1981.

8th International Gas Bearing Symposium, Leicester, UK, 8-10 April 1981.

International Seminar on the Role of Finite Element Methods in Radiation Physics, London, UK, 23-24 April 1981.

Symposium on "Polymer Liquid Crystals—Science and Technology," Portofino, Italy, 18-22 May 1981.

International on Osteoporosis, Jerusalem, Israel, 31 May-4 June 1981.

International Symposium on Locational Decisions (ISOLDE II), Skodsborg, Denmark, 15-18 June 1981.

Conference on "Modification of the Surface Properties of Metals by Ion Implantation," Manchester, UK, 24-26 June 1981.

VIth International Bioelectrochemical Conference, Kibbutz Kiryat Anavim, Israel, 28 June-3 July 1981.

9th International Conference on Operational Research, Hamburg, Germany 20-24 July 1981.

International Symposium on Advances in Polymer Characterization, Durham, UK, 13-17 July 1981.

International Symposium on Hydrodynamics in Ocean Engineering, Trondheim, Norway, 24-28 August 1981.

4th International Symposium on the Chemistry of Novel Aromatic Compounds (ISNA 4) Jerusalem, Israel, 30 August-4 September 1981.

NATO Advanced Study Institute on "Static and Dynamic Properties of the Polymeric Solid State," Glasgow, UK, 6-18 September 1981.

European Visitors to the US Supported by ONR London

Visitor	Affiliation	Navy Lab./Org. to be Visited
	SPRING 1981	
Prof. Evan-Wyn-Jones	Dept. of Chemistry, Univ. of Salford, UK	NRL, Marine Physical Laboratory, Scripps
Prof. J.W.R. Griffiths	Loughborough Univ. of Technology, Loughborough, UK	NOSC, NRL, NUSC (April/May)
Dr. D.E. Packham	Univ. of Bath, School of Materials Science, Bath, UK	NSWC, White Oak (May)

ONRL REPORTS

C-7-80

International Union of Theoretical and Applied Mechanics: 3rd Symposium on Creep in Structure by Terry R. McNelley

The 3rd Symposium on Creep in Structures was held September 8-12 1980 at the University of Leicester, Leicester, UK. The Symposia in this series occur once every ten years with the aim to review developments in the area of creep and creep mechanics. As such, this Symposium, with a total attendance of about 70, attracted many prominent workers in this field. Over the years, emphasis in this field has shifted from analysis of creep mechanics toward the problems of cavitation, void formation, creep cracking and rupture. This change is in part a result of metallurgical developments leading to stronger, more creep resistant materials but also less ductile materials. This was reflected in this Symposium as half the papers dealt with the various problems in the areas of cavitation, creep crack propagation and rupture. Futhermore, there was a significant input from Metallurgy and Materials' Science and the promotion of interaction between the Mechanics and Materials' Science approaches to the subject of creep was an important secondary aim of this Symposium.

C-8-80

5th International Conference on Marine Corrosion and Fouling by E.C. Haderlie and R.C. Tipper

This is a brief account of the Fifth International Congress on Marine Corrosion and Fouling held in Barcelona in May 1980. A list of the papers presented is included, however, no abstracts are given for the preprints of all papers have been published and distributed.

C-9-80

Second International Conference on Superconducting Interference Devices and Third Workshop on Biomagnetism by J.R. Neighbours

This report covers the conferences on superconducting quantum interference devices and biomagnetism held in West Berlin on 6-9 May 1980. Subjects discussed were junction physics, junction and circuit noise, fabrication of junctions and circuits, high and low frequency applications, and applications. Ten invited and 62 contributed papers were presented at the SQUID conference.

C-10-80 Meeting on the Physics of Transition Metals Leeds, UK, 18-22 August 1980 by J.R. Neighbours for Dimitris Papaconstantopoulos and Barry Klein

This report covers the conference on transition metals held in Leeds on 18-22 August 1980. Subjects covered were band theory, ferromagnetism, ultrasonic attenuation, neutron scattering, magnetism, Fermi surfaces, positron annihilation, lattice dynamics and heats of formation. The meeting included 25 papers, 4 poster sessions and a panel discussion on magnetism in metals.

C-11-80 Report on International Conference on Radio Spectrum Conservation Techniques, London, 7-9 July 1980 by G.M. Sokol

This is a review of the highlights of a conference reviewing the results of recent research in developing improved techniques for reducing the requirements for bandwidth in communications. Bandwidth-efficient interference resistant modulation, frequency re-use, cellular organization of h short range transmitters, and satellite systems are among the techniques discussed. Areas of interest include mobile radio, broadcasting telephone systems, satellite systems, and spectrum planning, assignment and measurement.

C-12-80 European Workshop in Leadership and Managerial Behavior—University of Aston Management Centre by J.G. Hunt

The European Workshop in Leadership and Managerial Behavior was held at the University of Aston Management Centre on 17-19 May 1980. The workshop brought together European and British academics active in the areas broadly described as leadership and management. The workshop provided the opportunity to explore the relationship of European activities and ideas in this field to those of US scholars. More importantly, it provided the basis for an informal European network of scholars within these areas similar to that now existing in the US.

C-13-80 Climate and Offshore Energy Resources by Paul F. Twitchell

A conference was held in London from 21-23 October 1980 to discuss the relationship of climate to the world's offshore energy resources. The conference focused upon such areas as the impact of oil resources upon the economies of developed and developing countries, the importance of providing climatic data in sufficient time to meet users' needs, and the hazards and financial burdens associated with the development of offshore oil reserves. One of the important achievements of the conference was the establishment of better communications between the users of environmental data and those charged with producing predictions.

C-14-80 16th International Symposium on Applied Military Psychology by M.J. Farr

This report summarizes the presentations made at the 16th International Symposium on Applied Military Psychology held in Amsterdam from 19-23 May 1980. Departing from previous conference formats, which had one dominant theme, the 1980 Symposium emphasized profound discussions of many specific topics. These included the psychological stress of military life, psychological dysfunctioning, evaluation of officer selection systems, attitudes of male officer cadets towards female officers, and the ingredients of heriosm.

R-2-80 Energy from the Bowels of the Earth—Vulcanism and its Uses in Iceland by R.E. Machol

Iceland is far ahead of the rest of the world in the use of geothermal energy for hot water and space heating, but they have run into severe difficulties in generating electricity from this source. The present report describes these difficulties and some of the people involved.

R-3-80 Key Organizational and Management Research Thrusts in Europe by J.G. Hunt

A sabbatical at the University of Aston Management Centi Birmingham, UK and visits to other similar UK and Dutch centers revealed major thrusts in the nature of organizational and management research in Europe.

In general, there is considerable research of this kind being conducted in Europe. Its flavor is summarized in this report.

The work differs from that being done in the United States in a number of ways. One is the emphasis on cross-national studies. There are a number of such European projects involving centralized research designs but decentralized funding and implementation modes across institutions in different countries. While such research is done in the US, it does not play the dominant role demonstrated here. Neither is the centralized design, decentralized implementation mode common.

A second difference is the emphasis on research concerning work place participation. Though rare in the US, such schemes are commonplace in Europe. A third difference is in the way leadership research is treated in Europe and the US. Such work is more heterogeneous in Europe and is frequently treated as part of another project, not as a research area in its own right as in the US.

R-5-80 A Partial Review of Marine Science in Western Europe by Wayne V. Burt

This review contains short summaries of marine research and comments on these activities. Each country summary is followed by a series of discussions of individual centers of marine research. The discussions include the research programs, sources of funding, key personnel, trends, and comments. The review is essentially complete for Spain, Portugal, and The Netherlands, and partially complete for the UK and France.

R-7-80 Research Policy in the Federal Republic of Germany by W.J. Condell, Jr.

The research policy of the Federal Republic of Germany as described in Bundesbericht Forschung VI, 1979 is abstracted and compared with trends in the OECD nations as described by the OECD Committee for Scientific and Technological Policy, 1978. Funding estimates for R&D sectors are given. Lists are given of the Big Science establishments, the Max-Planck institutes, and the Fraunhofer institutes.


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